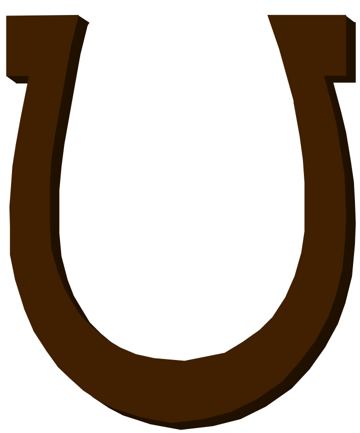
Production Estimation

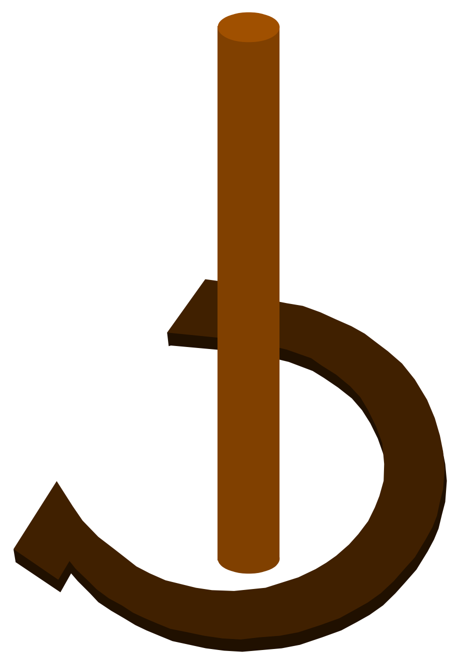
Purpose

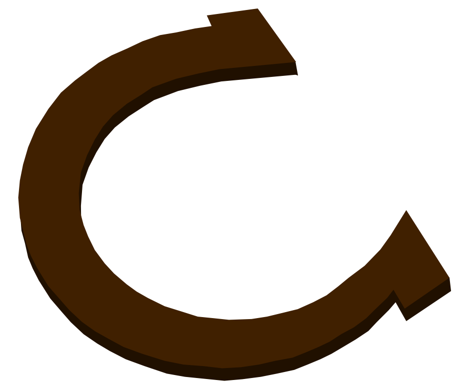
- To teach you how to accurately estimate an equipment oriented job by using given estimation production times and procedures.

Learning Objectives

- Terminal Learning Objective
- Enabling Learning Objective







Method and Media

- Lecture , demonstration and practical application Methods
- Computer Generated Slides

Evaluation

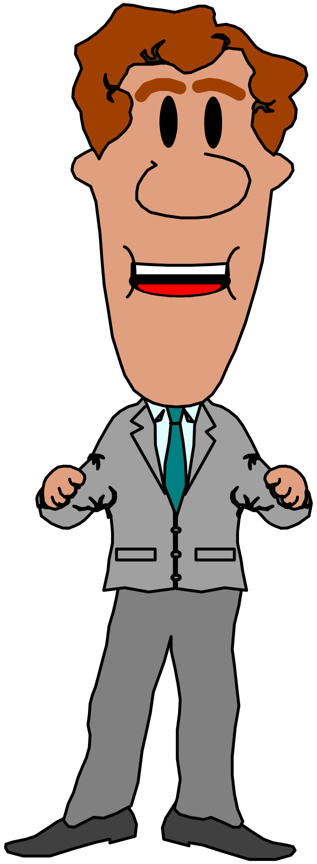
- Practical applications using each Production Estimation Formula.
- **<u>Open book exam!</u>**

SAFETY/CEASE TRAINING

ANY QUESTIONS?

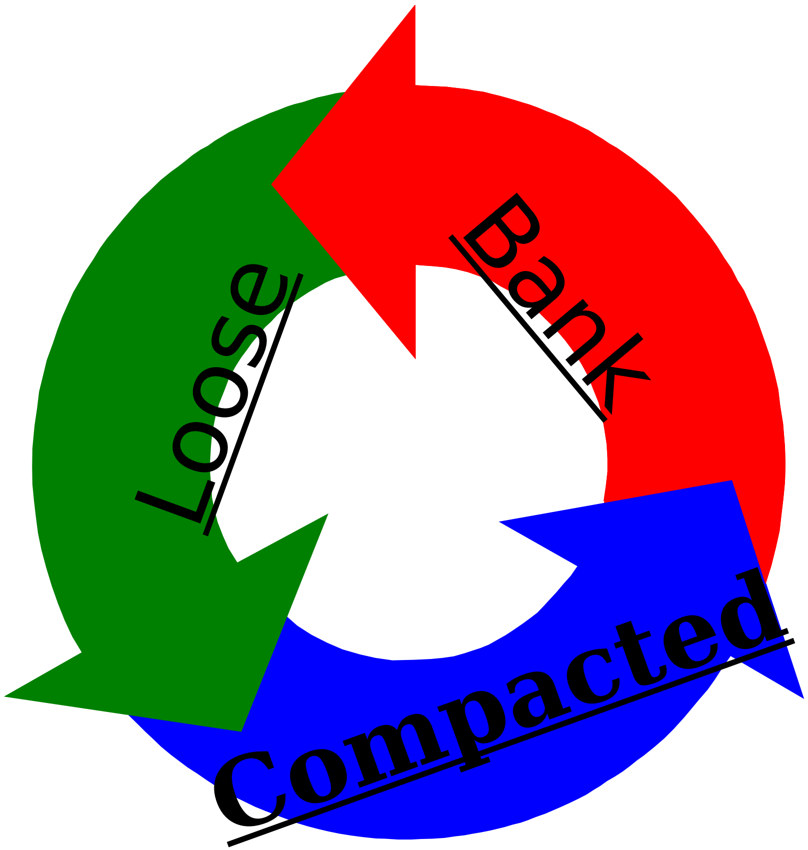
Estimating

- The art of determining the size of the job, labor, equipment needed to perform the job and quantities of materials.
- To do any type of estimation, you need to know some



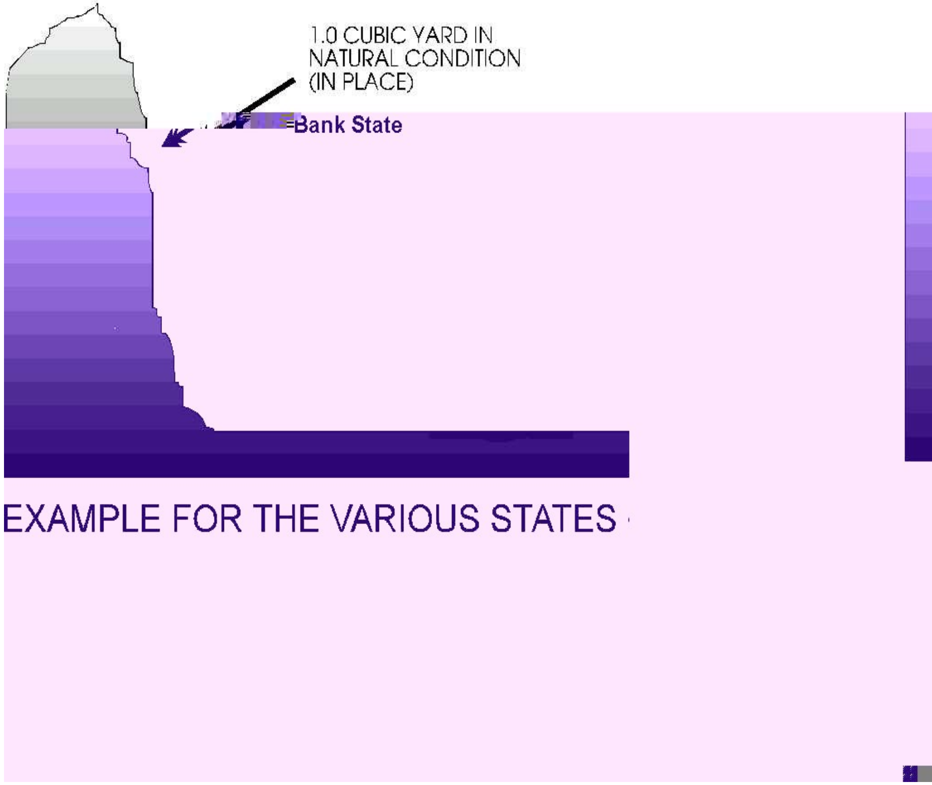
Soil States

- Soil is found in three states.
  - Sometimes it is necessary to convert from one volume to another.
  - To do this we use table #1-1.



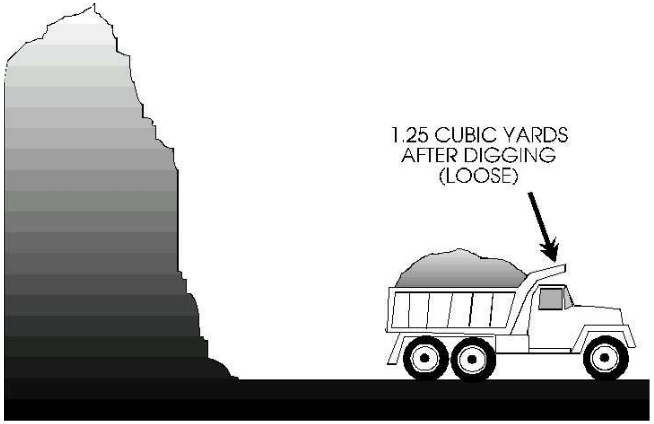
Bank State

- Any soil that has not been disturbed from its natural state for at least ten years.
  - This is also known as Bank Cubic Yards (BCY).



Loose State

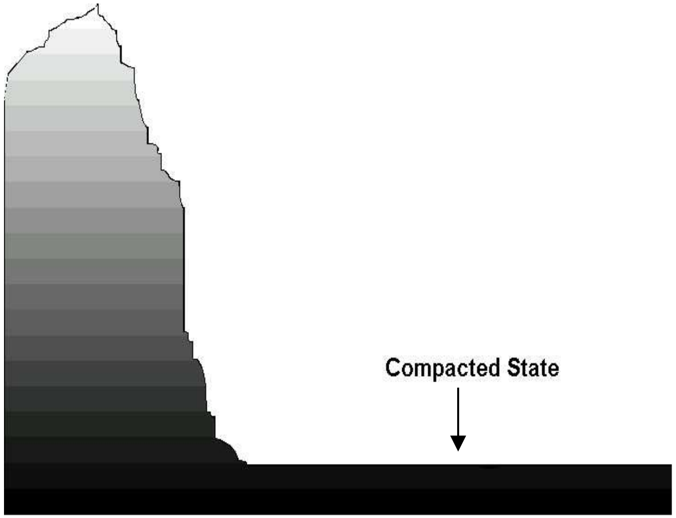
- Any soil that has been disturbed.
  - Note: Soil is always in a loose state when hauled, worked or stockpiled.
  - This is also known as Loose Cubic Yards (LCY).



EXAMPLE FOR THE VARIOUS STATES

Compacted State

- Any soil that has been compacted by artificial means.
  - This is also known as Compacted Cubic Yards (CCY).



EXAMPLE FOR THE VARIOUS STATES

Table #1-1 Soil Conversion Factors

Soil	***Converted From:***	***Bank***	***Loose***	***Compacted***
Sand or Gravel	Bank Loose Compacted	* .90 1.05	1.11 * 1.17	.95 .86 *
Loam	Bank Loose Compacted	* .80 1.11	1.25 * 1.39	.90 .72 *
Clay	Bank Loose Compacted	* .70 1.11	1.43 * 1.59	.90 .63 *
Rock (Blasted)	Bank Loose Compacted	* .67 .77	1.50 * 1.15	1.30 .87 *
Coral Comparable To Limestone	Bank Loose Compacted	* .67 .77	1.50 * 1.15	1.30 .87 *

Example

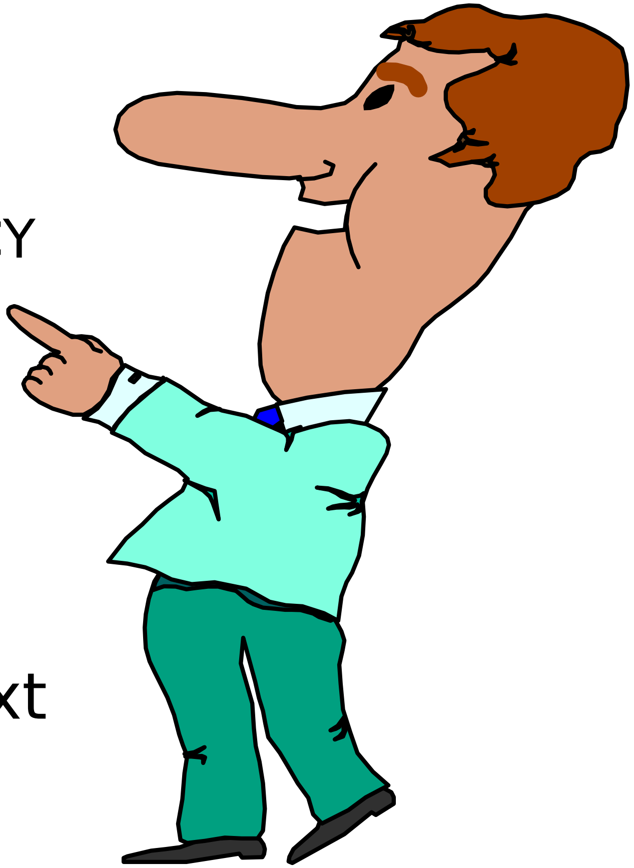
- If we needed to make a road that is 1,500’ long with a 3” lift of gravel and 24’ wide, it would be necessary to compute the volume first in compacted cubic yards and then convert it to a loose state.
- This determines how much material our haul units would have to move.
- This is done by multiplying the volume of the compacted material by a conversion factor.

Solution

3” ÷ 12” = .25’

1500’ (L) x .25’ (H) x 24’ (W) =

9000’ ÷ 27 = 333.33 or 334 CCY



334 CCY

x1.17 Conversion Factor

390.78 or 391 LCY

Note: Round up to the next full cubic yard.

What Have You Learned?

- Problem #1
- Your crew is tasked to dig a trench which is 300’ long, 9’ wide, and 6’ deep.
  - Earth loam, dry and the soil has been undisturbed for more than 10 years.
  - Using a 420 DV
  - How many loose cubic yards of soil will you remove?

Solution

$$\frac{300' \times 9' \times 6'}{27} = 600 \text{ BCY}$$

600 BCY x 1.25 = 750 LCY

What Have You Learned?

- Problem #2
- In the previous problem you removed ___ LCY of soil.
- However you requirement for a road you are working on is 16,600 CCY.
- Will you have enough soil to do the road?
- If yes, how much

Solution

750 LCY x .72 = 540 CCY

16,600 CCY
- 540 CCY

16,060 CCY under

Production Time

- Each piece of equipment has its own production formula.
- Basic Formulas
- Cubic Yards Per Hour (CYPH)

- Loose Cubic Yards/Hour (LCYPH)
- Bank Cubic Yards/Hour (BCYPH)
- Compacted Cubic Yards/Hour (CCYPH)

Cubic Yards Per Day (CYPD)

- Total cubic yards moved per hour multiplied by the total hours worked per day.

- Example:

  100 CYPH x 8 hr work/day = 800 CYPD

  Note: Round down CYPD

Production Days

- Total requirement of material needed divided by the total CYPD moved.

- Example:

  16,600 req CY ÷ 800 CYPD =

  20.75 or 21 days

  Note: Round up days to next full day.

What Have You Learned?

- Problem #1
  - You are moving 150 LCYPH
  - Working 5 hours per day.
  - The requirement to be moved is 17,000 LCY.
  - LCYPD?
  - Total Days?

Solution

150 LCYPH x 5 Hrs/day = 750 LCYPD

17,000 Req LCY ÷ 750 LCYPD = 22.67 or 23 days

What Have You Learned?

- Problem #2
  - You are moving 250 LCYPH
  - Working 8 Hrs/day.
  - The requirement to be move is 18,000 LCY.
  - LCYPD?
  - Total Days?

Solution

250 LCYPH x 8 Hrs/day = 2,000 LCYPD

18,000 Req LCY ÷ 2000 LCYPD = 9 days

QUESTIONS?

QUESTIONS TO CLASS

a. What is estimating?

The art of determining the size, equipment, personal, and quantities needed for a project.

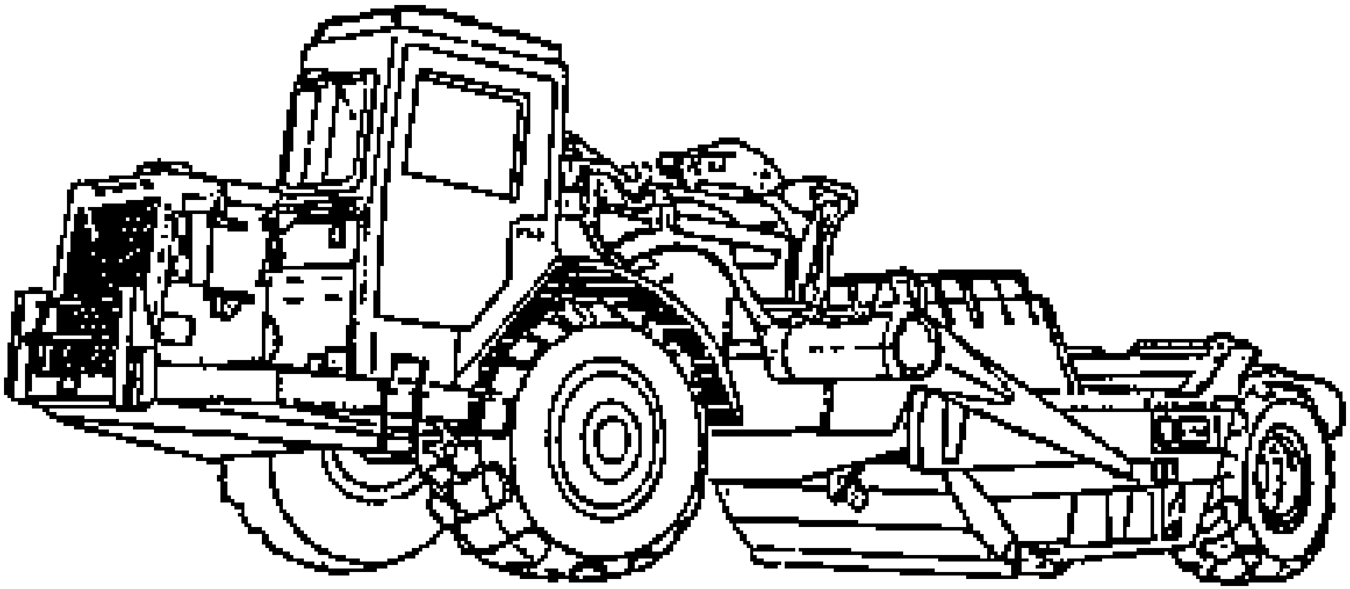
b. What are the three states of soil?

Bank, Loose, Compacted

c. What does CCYPH mean?

Compact Cubic Yards Per Hour (CCYPH)

BREAK!!!!!!!!!!



Scrapers

- Designed for loading, hauling and dumping on long haul earthmoving operations.
- Has 3 basic operational parts; the bowl, the apron, and the ejector.
- The bowl, which is equipped with a cutting edge on the front bottom, is the loading and carrying component.
- The apron is the front wall of the bowl, and can be raised and lowered independently of the bowl.
- The ejector is the rear wall of the bowl. It is moved back to load, and forward to discharge materials.

Scraper Uses

- Scrapers serve the primary purpose of loading and hauling material.
  - The distinct advantage of the scraper, is the ability to load, haul, and spread in one continuous cycle.
  - Capacity is measured in heaped and struck capacity.
  - Capable of working alone for leveling operations, but is supplemented with push-tractors for cut and fill operations.

Classification

- Classified according to load capacity and rated load.
  - A heap load is the maximum load of the machine.
  - A struck load is the minimum effective load.

Characteristics

- Wheeled vehicle characterized by a tractor and a scraper.
- Prime movers in cut and fill operations and in bringing elevations to rough, final grades.
- Open bowl design, they can be loaded from above.
- 3 types of cutting edges:
- Straight, Curved, and the 3 piece cutting edge.
- **The 621B has a rated load weight of 48,000 lbs.**

Operation

- Hydraulically operated and powered by a tractor.
- Most efficient during downhill loading.
- Other methods of production include straddle loading and pump loading.
- All loading should be accomplished with a pusher, within (1) minute, and within (100) feet of travel.

Types Of Loads

- Struck load:
  - Loaded with soil until the material is approximately even with the top of the side boards.
  - The capacity of the 621B Scraper, when

- Heap load:
  - Loaded with soil when the material is overflowing the side boards.
  - The capacity of the 621B Scraper, when heap loaded, is *18 Loose Cubic*

Actual Load Size (ALS)

- Actual load size (ALS) will vary considerably, being somewhere between struck & heap due to variables such as:
  - Soil weight
  - Moisture Content
  - Manner in which scraper is being loaded.

QUESTIONS

Scraper Production

- 15 Step process

Soil Weight

- Soil weight is used in all production.
- To determine the actual soil weight (ASW) per cubic yard, start by taking the soil weight from table #2-2.

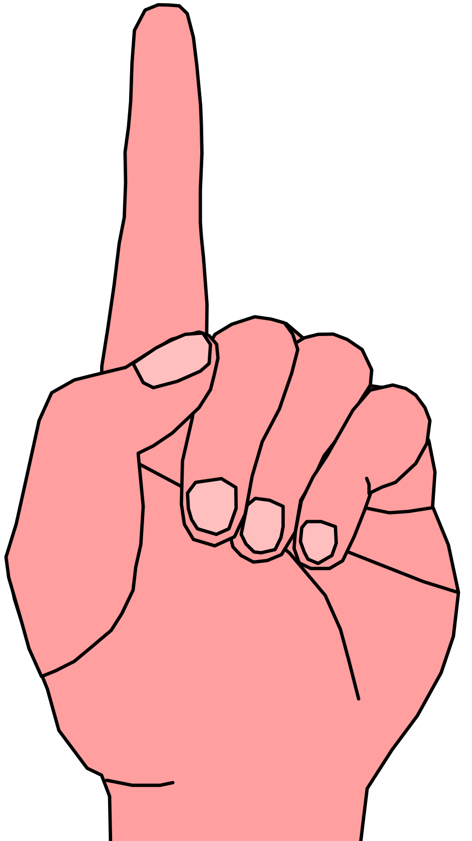


Table #2-2 Approximate Weight of Soil

PER CUBIC YARD

Type Of Soil	***Pounds Per (CY)***	*Type Of Soil*	*Pounds Per (CY)*
Cinders	1,200 lbs.	Limestone	2,500 lbs.
Clay, Dry	2,000 lbs.	Sandstone	2,200 lbs.
Clay, Wet	3,000 lbs.	Sand, Dry	2,900 lbs.
Clay, Gravel	2,700 lbs.	Sand, Wet	3,100 lbs.
Gravel, Dry	3,000 lbs.	Shale & Soft Rock	2,700 lbs.
Gravel, Wet	3,100 lbs.	Slag, Bank	1,940 lbs.
Earth Loam, Dry	2,200 lbs.	Slate	

Moisture Content

- Moisture weight in the soil.
  - Although table #2-2 shows some soils with moisture, it may be necessary to get an exact moisture content to determine soil weight.
  - The moisture will

- Soil analysis personnel are trained to determine the moisture content, and the weight of this moisture must be calculated and added to the

Actual Soil Weight (ASW)

- Method used to determine ASW.
- Example:
- Earth Loam with a 7% moisture content.
  - Earth loam weighs 2,200 lbs/cubic yard.
  - Multiply 2,200 by 1.07 to get the moisture weight of
- The initial moisture content is 7% of the original weight.
  - Therefore, the actual soil weight is 107% of the original weight.
  - Convert the percentage to a decimal.
  - Multiply the

Actual Soil Weight (ASW)

- For classroom purposes:
  - ***If you are given a wet soil***, take the weight of the wet soil off table #2-2.
  - ***If you are not given either wet or dry condition***, take the weight of dry soil off table #2-2.
  - ***If you are given a wet soil and a moisture content***, take the weight of dry soil and multiply the moisture content.
- ***Never round off ASW***

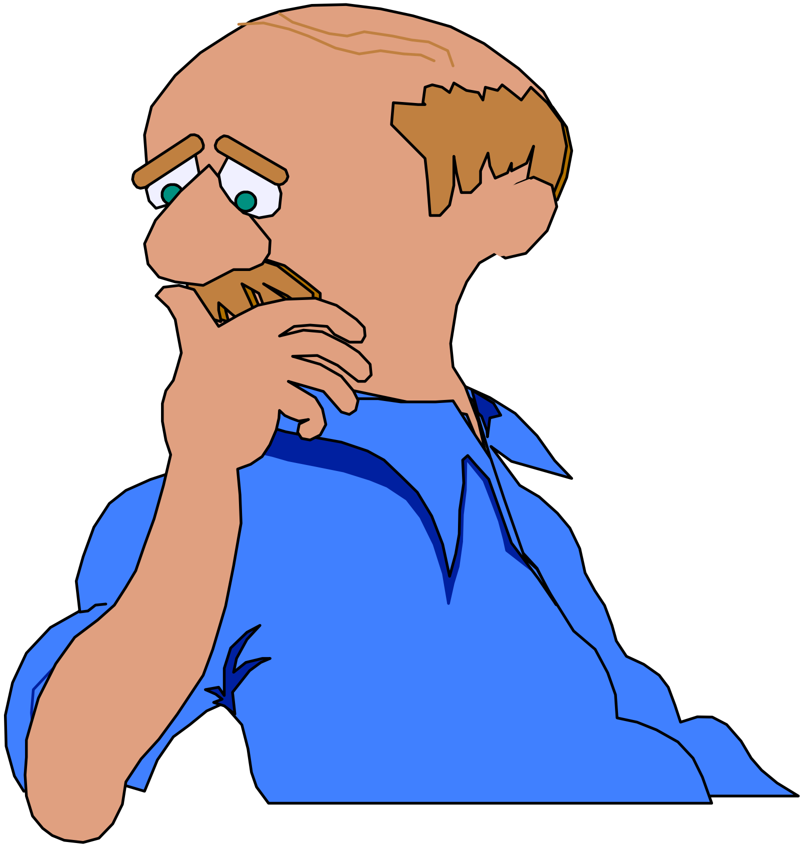
Scraper Production Step #1

- ***Actual Soil Weight (ASW).***
  – Remember never round off ASW.
- Example:
- Earth Loam weighs 2,200 lbs./CY. With 7% moisture content.

2,200 x 1.07 = 2,354 ASW

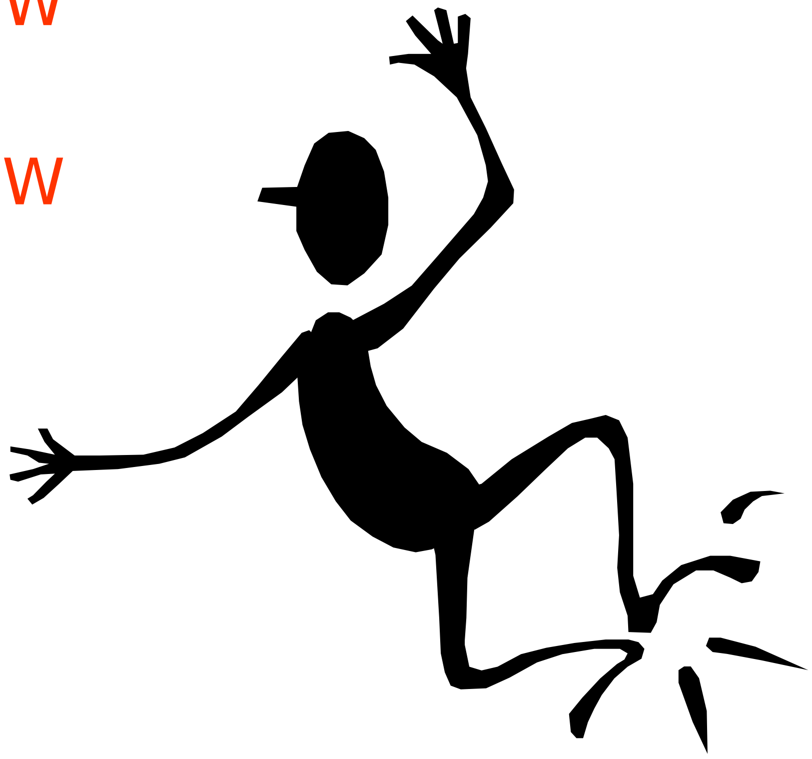
Try A Few

- Figure out the Actual Soil Weight (ASW) of the following:
  - Wet clay, with 14% Moisture.
  - Wet sand, with 17% moisture.
  - Soft coral, with 2% moisture.
  - Earth loam
  - Clay & gravel, with 18% moisture.



Solutions

- 2,000 x 1.14 = 2,280 ASW
- 2,900 x 1.17 = 3,393 ASW
- 2,030 x 1.02 = 2,070.60 ASW
- 2,200 ASW
- 2,700 x 1.18 = 3,186 ASW



Scraper Production Step #2

- ***Cubic Yards of a Load.***
  - You have to determine the maximum cubic yards you can haul without exceeding 48,000 lbs. (max load) or 18 cubic yards (max capacity).

- Example:
  48,000 lbs. (rated capacity)

  2,354 lbs. (Actual Soil Weight)

  20.39 CY No more than 18 CY
- If the resulting figure is less than 18, use that entire number as it appears on the calculator in step #3.
- If Push or Self Loading, this is your Actual Load Size (ALS) - go to Step #5

Scraper Production Step #3

- ***Buckets Loaded.***
  - ***Buckets loaded*** must be a whole number.
  - Divide cubic yards of a load by the bucket size.
- Example:

<u>18</u> Cubic Yards

2.5 Cubic Yards (bucket size
from table #3-2)

7.2 buckets or 7 bucket loads

- Note: Round down to whole buckets loaded.

Bucket Sizes Table #3-2

Type of Equipment	Bucket size
Tram 624KR	2½ or 2.5 CY
MC1155E	1¾ or 1.75 CY
MAC 50 CLAMSHELL	1¼ or 1.25 CY
420D Front Bucket	1 or 1.25
420D Backhoe Bucket	¼ or .25

Scraper Production Step #4

- ***Actual Load Size.***
  - The true amount of soil in haul unit.
  - Number of buckets multiplied by the bucket size.

- Example:

  7 #of Buckets

  x 2.5 TRAM Bucket Size

  17.5 cy Actual Load Size (ALS)

- Note: Never round off ALS.

Scraper Production Step #5

- ***Load Weight (LW).***
  - Multiply your ASW by your ALS.
  - Keep your load weight under 48,000 lbs.
  - Table #2-2 shows the weight of cinders as 1200 lbs./LCY.
  - A struck load would weigh 16,800 lbs., while the heap load would weigh 21,600 lbs..
  - These weights would be easily hauled, but it is a different story with other materials.
  - Take a look at Earth Loam, wet for instance:

3,200 weight of Earth Loam, wet/CY 3,200

x 14 LCY Struck x 18 LCY Heaped

44,800 lbs. Struck Loaded 57,600 lbs.

Example

- Each cubic yard weighs 2,354 lbs. (step #1), and you are hauling 17.5 cubic yards.

2,354 ALSW

x17.5 ALSS

41,195 load weight (LW)

- Note: Never round off load weight.

Scraper Production Step #6

- ***Short Tons***
  - First determine the gross weight of the vehicle with load.
  - Divide the gross weight by 2,000 lbs. (the weight of one ton).

CLEAR CALCULATOR

41,195 LW (step #5)

+ 66,590 Tractor weight

107,785 Gross weight

÷ 2,000 Weight of 1 ton

53.89 Short tons (ST)

- Example:

PRACTICAL APPLICATION

What Have You Learned?

- Problem #1
  - Figure the ASW of Gravel with a 12% moisture content.

- Solution:

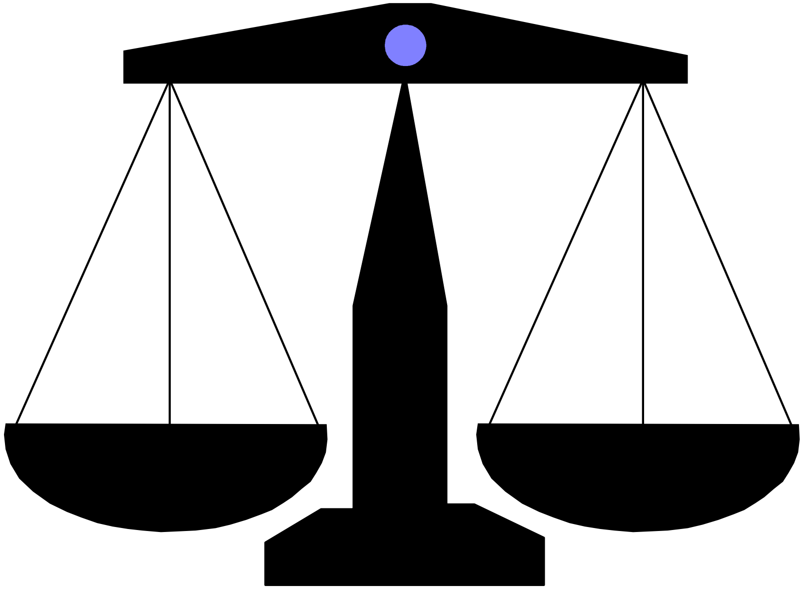
3,000 Weight of dry gravel

x1.12 Moisture content

3,360 lbs. ASW

What Have You Learned?

- ***Problem #2***
  - When hauling this gravel in a 621B loaded with a TRAM 624KR, what would the **load weight** be?



What Have You Learned?

- Solution:

48,000 Rated Capacity

<u>÷3,360</u> ASW

14.29 CY of load

<u>÷ 2.5</u> Bucket size

5.72 5

5 # buckets loaded

<u>x2.5</u> Bucket size

12.50 ALS

<u>x3,360</u> ASW

42,000 LW

What Have You Learned?

- ***Problem #3***
  - If the 621B has a load weight of 46,590 lbs., what would your **short tons** be?

- Solution:

46,590 LW

+66,590 Tractor weight

113,180 Gross weight

÷ 2,000 1 ton

56.59 ST

BREAK 10 MIN

Scraper Production Step #7

- ***Rolling Resistance***
  - The resistance of movement to wheeled vehicles over a haul surface caused by irregularities in the surface such as compacting and displacement of
  - Rolling resistance is measured by the rim pull in pounds per **short ton** required to overcome resistance.
  - This resistance effects the cycle time.

Scraper Production Step #7

- To do this multiply **short tons** (from step #6) by the **rolling resistance factor** (RRF) found in table #4-2).
- The resulting answer will be your *rolling resistance (RR).*

Table #4-2 Rolling Resistance Factors

Hard, Smooth, Stabilized roadway without penetration under load **(CONCRETE OR BLACKTOP)**	40 lbs. a ton
Firm, Smooth-Rolling roadway flexing slightly under load 1" penetration **(GRAVEL TOPPED ROAD)**	65 lbs. a ton
Rutted Dirt roadway, flexing considerably under load 2"-3" penetration **(SOFT CLAY ROAD)**	100 lbs. a ton
Rutted Dirt roadway, no stabilization under load 4"-6" penetration **(SOFT CLAY ROAD)**	150 lbs. a ton
No stabilization 7" or greater penetration **(SOFT, MUDDY, RUTTED ROADWAY, OR IN SAND)**	400 lbs. a ton

Example

- Determine the rolling resistance for a 621B scraper traveling **over firm, smooth-rolling roadway flexing slightly under load 1" penetration.**

- 53.89 ST (from step #6)

  x 65 RRF (from table #4-2)

  3502.85 or 3503 RR

- Note: Round Off Rule
  - Round up 5 or greater, round down 4 or less for RR.

PRACTICAL APPLICATION

What Have You Learned?

- Problem #1
  - Figure the Rolling Resistance for the following situation.
  - 621B Scraper
  - Struck loaded (self loaded)
  - Hard pan
  - Rutted, dirt

Step #1

3,100 ASW

- Step #2

  N/A

- Step #3

  N/A

- Step #4

  N/A

What Have You Learned?

- Step #5

  3,100 ASW

  x 14 ARSF

  43,400 LW

- Step #6

  43,400 LW

  +66,590 TR

  WT

  109,990 GW

  ÷ 2,000 1

What Have You Learned?

- ***Problem #2***
- Figure rolling resistance for the following situation.
  - 621B scraper
  - Loaded with a Tram (2½ CY bucket)
  - Trap rock
  - Hard, smooth

- Step #1

  3,500 ASW
- Step #2

  48,000 Rated Capacity

  ÷3,500 ASW

  13.71 CY of a load
- Step #3

  13.71 CY of a load

What Have You Learned?

- Step #4

  5 Buckets loaded

  <u>x2.5</u> Bucket size

  12.50 ALS

- Step #5

  3,500 ASW

  <u>x12.50</u> ALS

  43,750 LW

- Step #6

  437250 LW

  <u>+ 66,590</u> TR WT

  110,340 GW

  <u>÷ 2,000</u> 1 ST

  55.17 ST

- Step #7

  55.17 ST

Scraper Production Step #8

- ***Grade Resistance (GR) or Grade Assistance (GA).***
  - Rules of thumb generally accepted as reliable measures of the effect of grades are as follows:
  - Grade resistance effects the cycle time by slowing the scraper.
  - Grade resistance or Grade assistance is the increase, or decrease, in the amount of

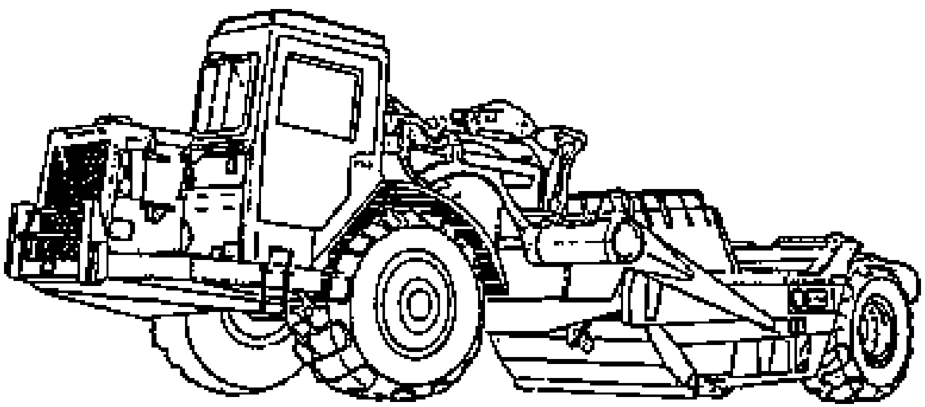
Scraper Production Step #8

- Each 1% of **uphill** grade increases the resistance by 20 lbs. Per short ton pull of gross vehicle weight.
- Formula:

Short tons x 20 (constant) x % of grade = **Grade resistance or assistance**.

Example

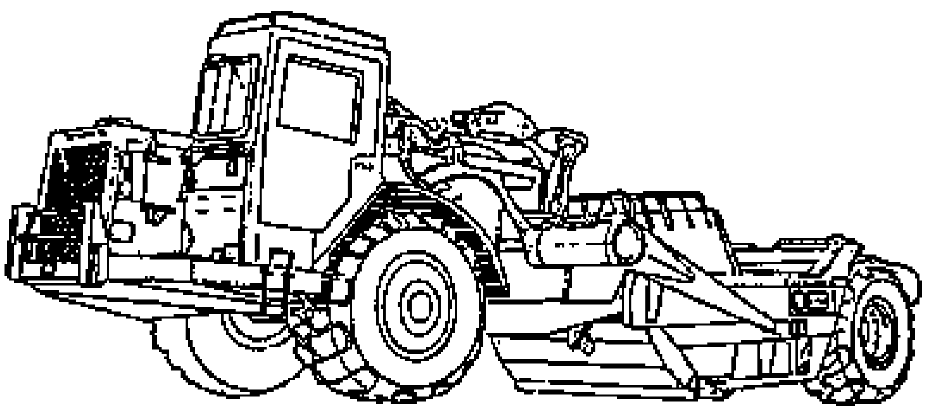
- The total weight of the loaded scraper on the haul is 107,785 lbs. (from step #6)
  - Calculate the grade resistance factor for climbing a (+2) uphill grade.



Example Solution

$$\frac{53.89}{\text{ST}} \times \frac{20}{20} \times \frac{2}{\%\text{ grade}} = \frac{2155.6 \text{ or } 2156}{\text{grade resistance (GR)}}$$

- **Note:**
  - **Round up 5 or greater, round down 4 or less (GR**

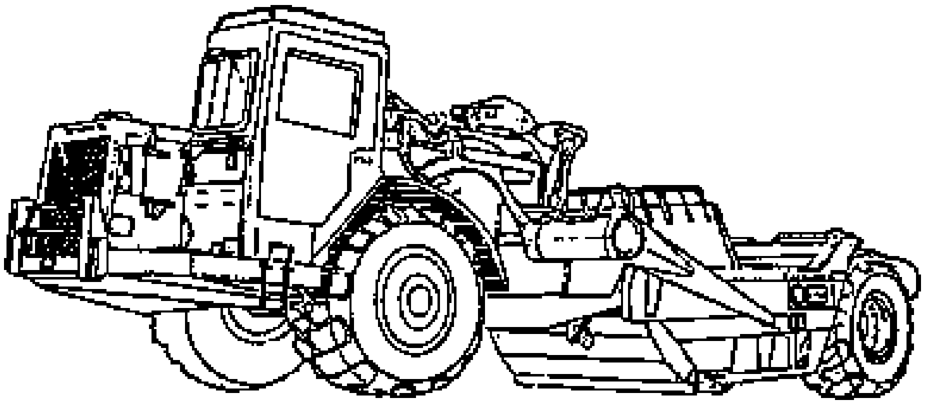


Scraper Production Step #8

- Each 1% of **downhill** grade decreases the amount of pull required by 20 lbs. Per short ton of gross vehicle weight.

Example

- For the return, the tractor is empty so the total weight is 66,590 lbs.
  - Calculate the grade assistance factor for (-2) downhill grade.



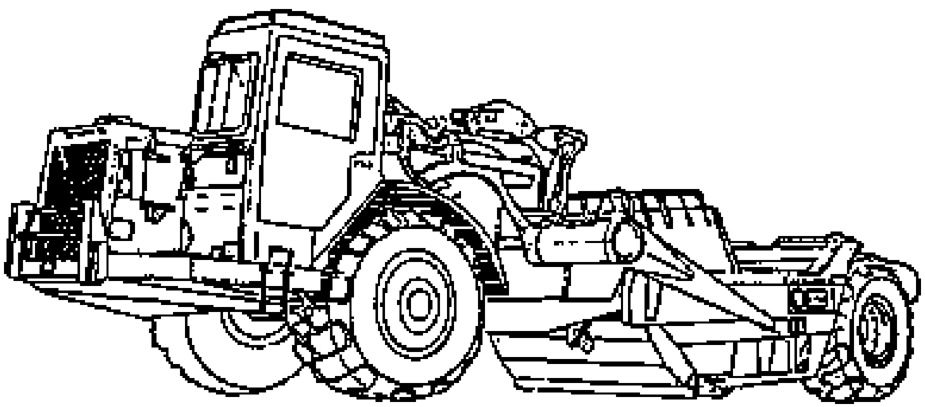
Example Solution

- 33.30 x 20 x -2 = -1,332

  ST empty x 20 x % of grade = Grade Assistance (GA)

- Note

  – Rou or less.
  (GR



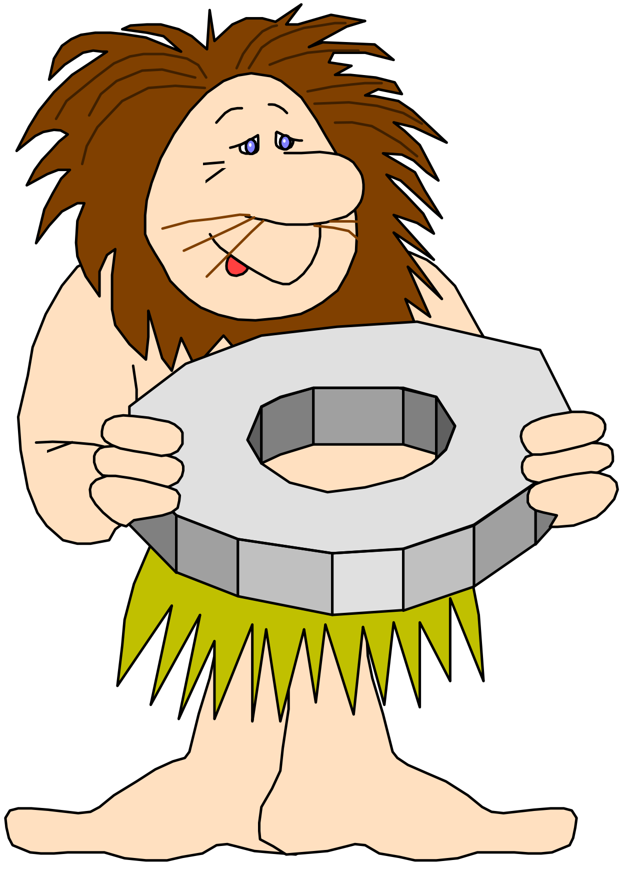
PRACTICAL APPLICATION

What Have You Learned?

- ***Problem #1***
- Determine **Grade Resistance** for a 621B with the following factors:
  - Struck load
  - Sand

  7% initial moisture

  3% Uphill grade



What Have You Learned?

- Step #1

  2,900 Soil WT

  x 1.07 Moisture

  3,103 ASW

- Step #2

  N/A

- Step #3

  N/A

- Step #4

- Step #5

  3,103 ASW

  x 14 ALS

  43,442 LW

- Step #6

  43,442 LW

  +66,590 TR WT

  110,032 GW

  ÷ 2,000 1 ST

  55.02 ST

What Have You Learned?

- Step #7

  N/A

- Step #8

  55.02 ST

  x 20 Constant

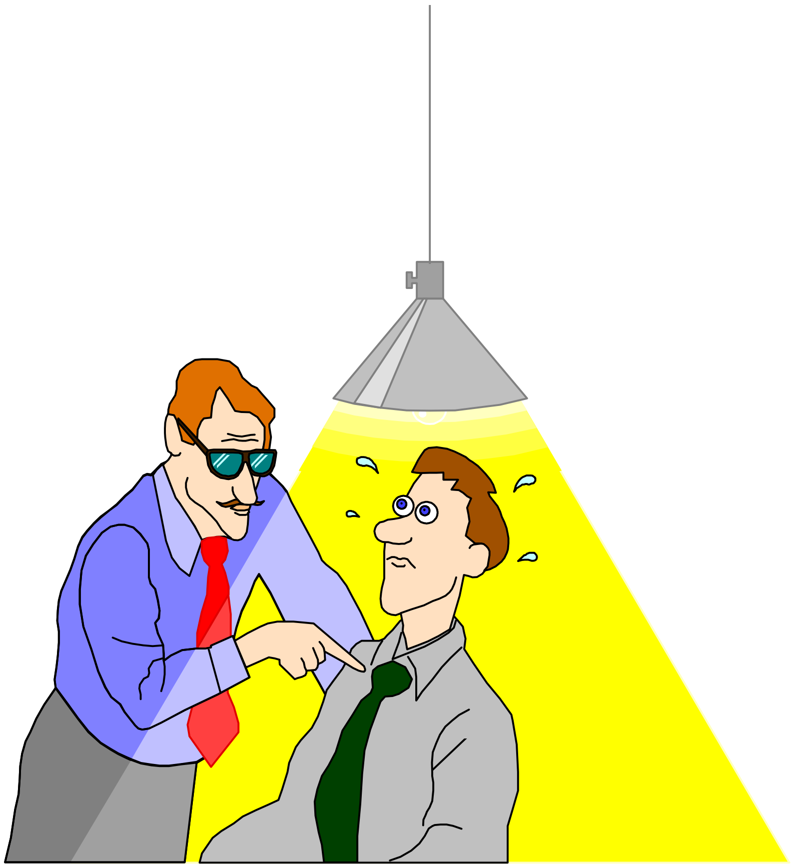
  x 3 % of grade

  3,301.20 or 3,301 GR

What Have You Learned?

Problem #2

- Determine **rolling and grade resistance** for a 621B on the haul with the following factors:
- Heap load
- Sandstone
- Rutted, dirt roadway, no stabilization under



What Have You Learned?

- Step #1

  2,200 ASW

- Step #2

  N/A

- Step #3

  N/A

- Step #4

  N/A

- Step #5

2,200	ASW
x 18	ALS
39,600	LW

- Step #6

39,600	LW
+ 66,590	TR WT
106,190	GW
÷ 2,000	1 ST
53.10	ST

What Have You Learned?

- Step #7

  53.10 ST

  x 150 RRF

  7,965 RR

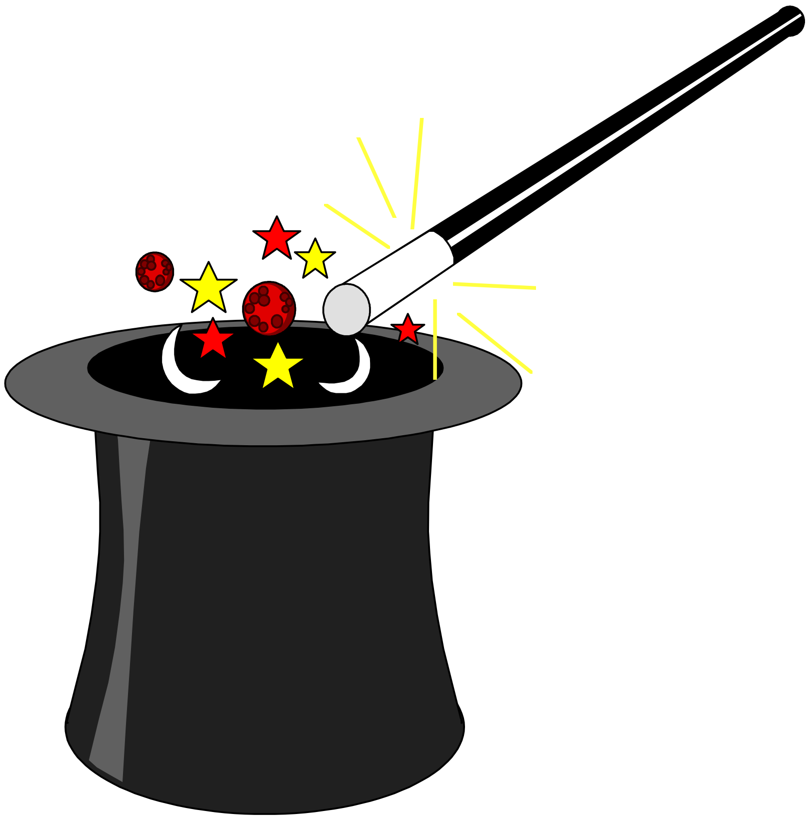
- Step #8

  53.10 ST

  x 20 Constant

  x 6 % of grade

  6,372 GR



Scraper Production

- Take a break!

Scraper Production Step #9

- ***Required Pounds Of Pull (REQPP)***
  - The total power required to move a unit.
  - We can find our ***REQPP*** by adding ***GR*** with ***RR*** from uphill, or Subtract ***GA*** from ***RR*** for downhill.
  - When on level ground, your ***RR*** is your ***REQPP***.

Example

- When traveling **uphill** a vehicle must overcome both rolling resistance and grade resistance.

3,503 RR

+2156 (+GR)

5,659 REQPP Using table #5-2, you can see that the scraper will not give you enough Rim Pounds Pull(RPP) in 8th or 7th gear, but 6th gear you have enough RPP. **The travel speed is 14 Mph.**

Table #5-2 **Power Characteristics of 621B Scraper**

Available RPP	35,062	23,375	16,187	13,148	9,146	6,657	5,008	3,393
Gear	1st	2nd	3rd	4th	5th	6th	7th	8th
TS Speed Mph	2	4	6	8	11	14	19	26

Scraper Production Step #9

- Note:
  - If your TM doesn't have the table, you can use the following formula to get your **RPP.**

$$\frac{375 \times \text{Engine HP} \times 80\% \text{ Efficiency}}{\text{travel speed in mph.}} = \text{Rim Pounds Pull (RPP)}$$

Example

- When traveling **downhill** a vehicle must overcome rolling resistance less grade assistance.

  2,165 RR
  -1,332 GA
  833 REQPP

  – Using table #5-2, we see that the scraper will give you enough RPP in 8th gear.
  – **The travel speed is 26 mph.**

- When traveling over level terrain, a vehicle must overcome rolling resistance only.

  3,503 RR = 3,503 REQPP

  – Using table #5-2, we see that the scraper will give you enough RPP in 7th gear.
  – **The travel**

What Have You Learned?

- ***Problem #12***
  - Determine **travel speed** with the following factors:
  - 621B scraper
  - Struck Load
  - Earth loam

  10% initial moisture
  - Hard, smooth roadway with no penetration under load.

  4% downhill grade.

What Have You Learned?

- Step #1

  2,200 Dry soil WT

  x 1.10 Moisture

  2,420 ASW

- Step #2
  - N/A
- Step #3
  - N/A
- Step #5

  2,420 ASW

  x 14 ALS

  33,880 LW

- Step #6

  33,880 LW

  + 66,590 TR WT

  100,470 GW

  ÷ 2,000 1 ST

  50.24 ST

What Have You Learned?

- Step #7

  50.24 ST

  <u>x 40</u> RRF

  2,009.6 or 2,010 RR

- Step #8

  50.24 ST

  x 20 constant

  <u>x -4</u> % grade

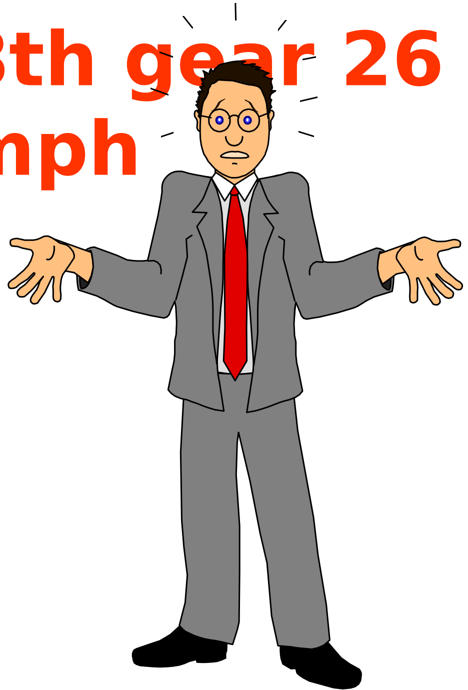
- Step #9

  2,010 RR

  <u>-4,019</u> GA

  -2,009 REQPP

  8th gear 26 mph

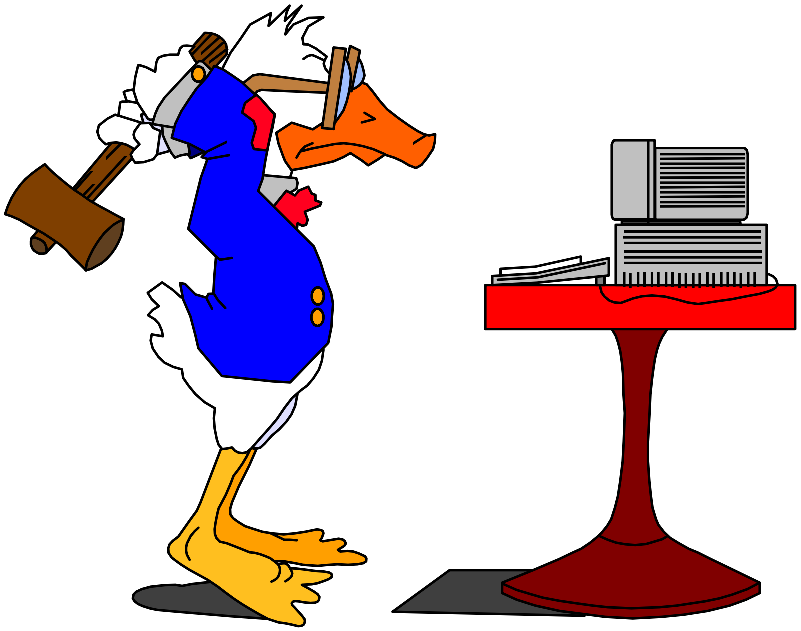


What Have You Learned?

- Problem #13
  - Determine the travel speed with the following factors:
  - 621B Scraper
  - Struck load
  - Clay and gravel

  3% initial moisture
  - Rutted, dirt roadway, no stabilization under load, 4”-6” penetration.

  6% uphill grade.



What Have You Learned?

- Step #1

  2,700 Dry soil WT

  x1.03 Moisture

  2,781 ASW

- Step #2
  - N/A
- Step #3
  - N/A
- Step #5

2,781	ASW
x 14	ALS
38,934	LW

- Step #6

38,934	LW
+ 66,590	TR WT
105,524	GW
÷ 2,000	1 ST
52.76	ST

What Have You Learned?

- Step #9 7

  52.76 27,914 ST RR

  x 1.331 + 16,531 RRC GR

  1,925 44,245 RR QPP

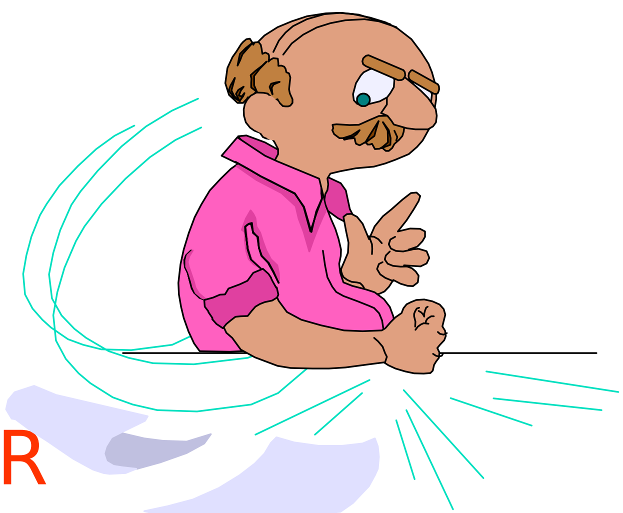
- Step #8 **3rd gear 6 mph**

  52.76 ST

  x 20 Constant

  x 6 % grade

  6,331.2 or 6,331 GR



Scraper Production Step #9

- ***Return***
  - The return is done by repeating steps 6-9 and **using empty vehicle weight** to get short tons.
- Example:
  - Step #6: ***Short tons (ST) with empty vehicle weight.***

    66,590 GW

  - Step #7: *Rolling Resistance (RR)*

    33.30 ST

    x 65 RRF

    2,164.5 or 2,165 RR

  - Step #8: *Grade Resistance/Assistance (GR/GA)*

33.30 ST x 20 x -2

Scraper Production Step #9

- Step #9: *Required Pounds Of Pull (REQPP) & Travel Speed.*

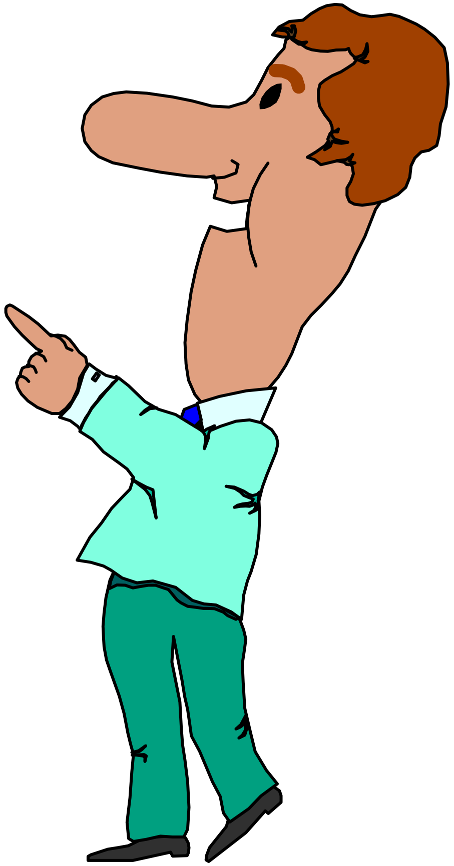
2,165	RR
<u>-1,332</u>	GA
833	REQPP

8th gear / 26 mph

- Now that you have you travel speed for haul **and return**, you can formulate the cycle time (step 10).

Scraper Production Step #10

- ***Cycle Time***
  - The time required to **Load, Haul, Spread**, and **Return**.
  - This is figured by adding ***Fixed Time (Fix-T)*** and ***Travel Time (TT)*** to get ***Cycle Time (CT)***



Scraper Production Step #10

- Fixed Time:
  - Is the time spent during an equipment cycle other than hauling and returning.
  - This includes positioning , loading, unloading, turning, accelerating and decelerating, all of which are fairly constant or fixed.
  - Fixed times are determined from Table #6-2.
  - To use Table #6-2, start with what gear you are in.

Scraper Production Step #10

Table #6-2 Fixed Time

Equipment	1st,2nd,3rd		4th		5th,6th,7th,8th	
Loading	Gear Haul		Gear Haul		Gear Haul	
Scraper	Struck	Heap	Struck	Heap	Struck	Heap
Scraper Loading Itself	2.50	N/A	2.80	N/A	3.0	N/A
1155E	7.0	9.0	7.30	9.30	7.50	9.50
TRAM	6.0	7.0	6.30	7.30	6.50	7.50
1085 w/1.5 bucket	12.0	14.0	12.30	14.30	12.50	14.50

Scraper Production Step #10

- Travel Time:
  - The time spent on the haul road transporting material and returning empty.
  - Travel Time depends on: size of hauling unit, rolling resistance, grade resistance, and distance traveled.
  - All of which have already been figured to get your gear selection and speed to put in your cycle time formula.

Scraper Production Step #10

- To figure cycle time (CT) you must first figure travel time (TT).
  - To get travel time divide the distance in feet of the haul or return road by the sum of the travel speed (TS) in mph multiplied by 88.
  - Do this for the haul and return.
  - The total time plus fixed time will equal total cycle time.
  - Note: 88 is he conversion factor to change the speed in mph to feet

Example

- A 621B scraper, hauling 17.5 CY of material, travels 7500’ to the fill area using 6th gear and returns empty by a different route of 8200’ in 8th gear

- 7500’ haul dist.
  14 TS x 88 = 6.09 HT

- 8200’ return dist.
  26 TS x 88 = 3.58 RT

What Have You Learned?

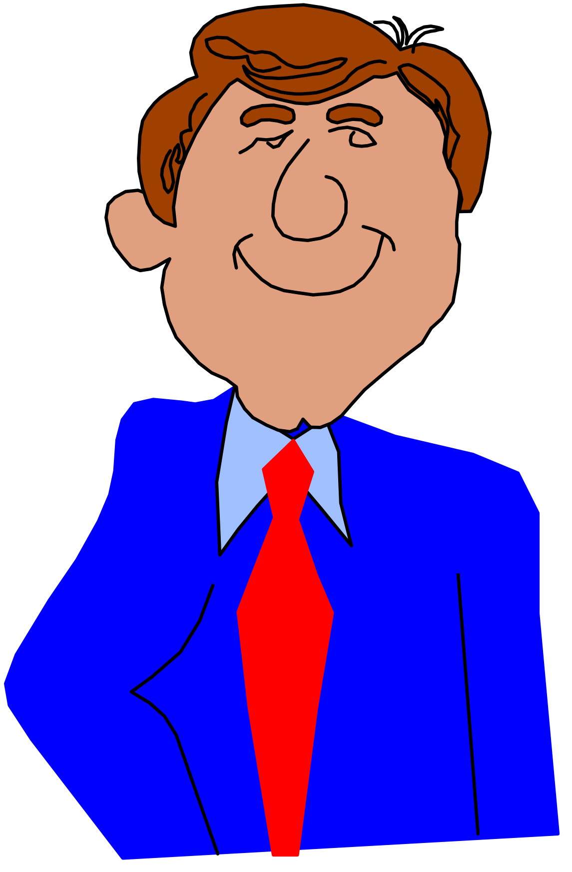
- Problem #14
  - Figure total cycle time.
  - 621B, self loaded
  - Haul distance - 8250’
  - Return distance - 7125’
  - Haul gear - 4th
  - Return gear - 8th

Solution

- 8250’ HD
  8 TS x 88 = 11.72
  HT

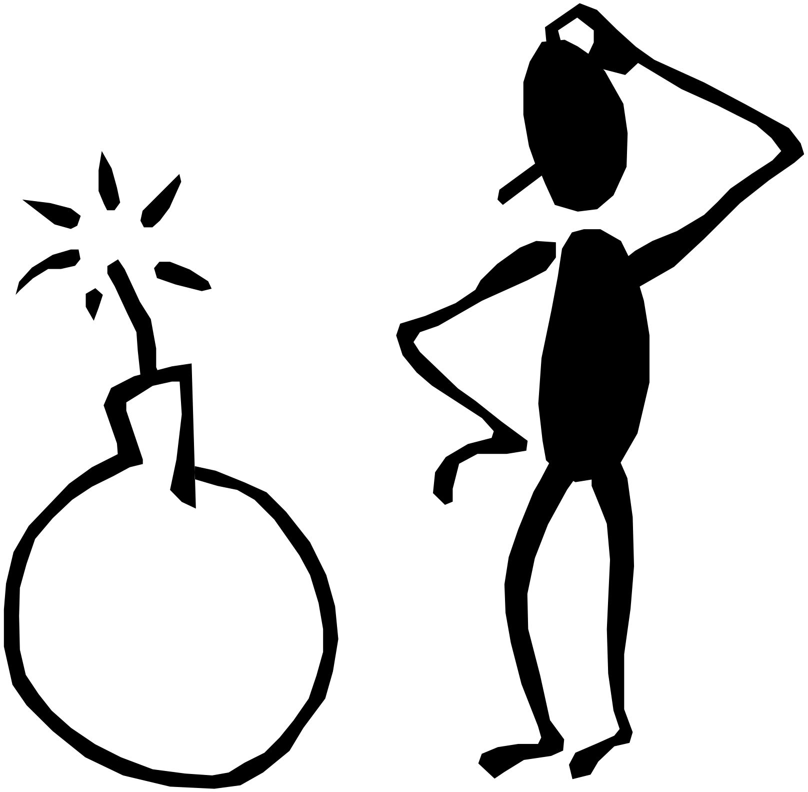
- 7125’ RD
  26 TS x 88 = 3.11
  RT

- 11.72 + 3.11 + 2.80
  =
  17.63
  CT



What Have You Learned?

- Problem #15
  - Figure total cycle time.
  - 621B, self loaded
  - Haul distance - 9000’
  - Return distance - 9176’
  - Haul gear - 6th
  - Return gear - 8th



Solution

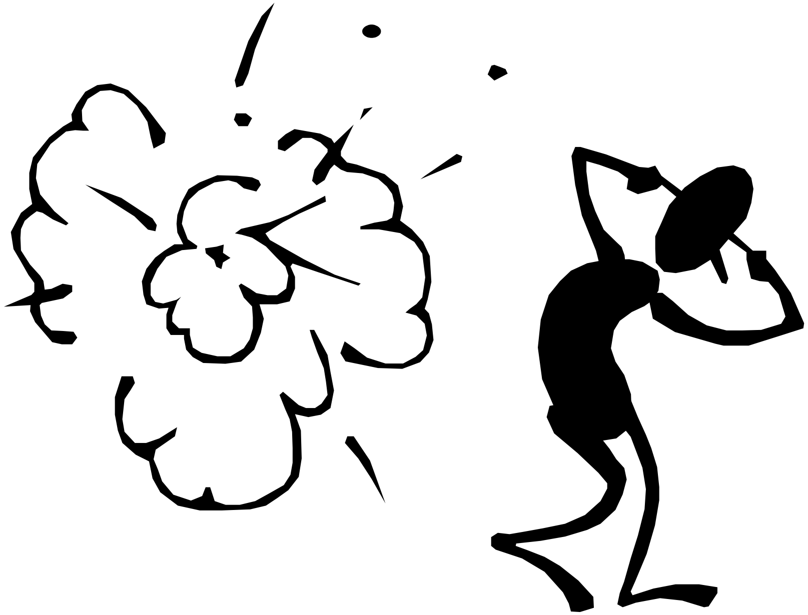
- <u>9000’</u> HD

  14 TS x 88 = 7.31 HT

- <u>9176’</u>RD

  26 TS x 88 = 4.01 RT

- 7.31 + 4.01 + 3.0 = 14.32 min CT



Scraper Production

- Take A Break!

Scraper Production Step #11

- ***Trips Per Hour***
  - To determine trips per hour **(TPH)** divide the working minutes per hour (normally 60 min. work hour) by the cycle time
  - Note: never round off TPH.

- Example:
  - How many trips per hour can a 621B make during a 60 min. work hour if it has a 17.17 min. cycle time?

$$\frac{60 \text{ min. worked/hr}}{17.17 \text{ CT}} = 3.49 \text{ TPH}$$

Scraper Production Step #12

- ***Hourly Production Rate (LCYPH)***
  - To determine the hourly production rate, you must know the actual load size (in LCY), the number of trips per hour,

- TPH
  x ALS
  x Efficiency Factor
  = LCYPH
- Note: always round down LCYPH.

Scraper Production Step #12

Table #7-2 Efficiency Factor

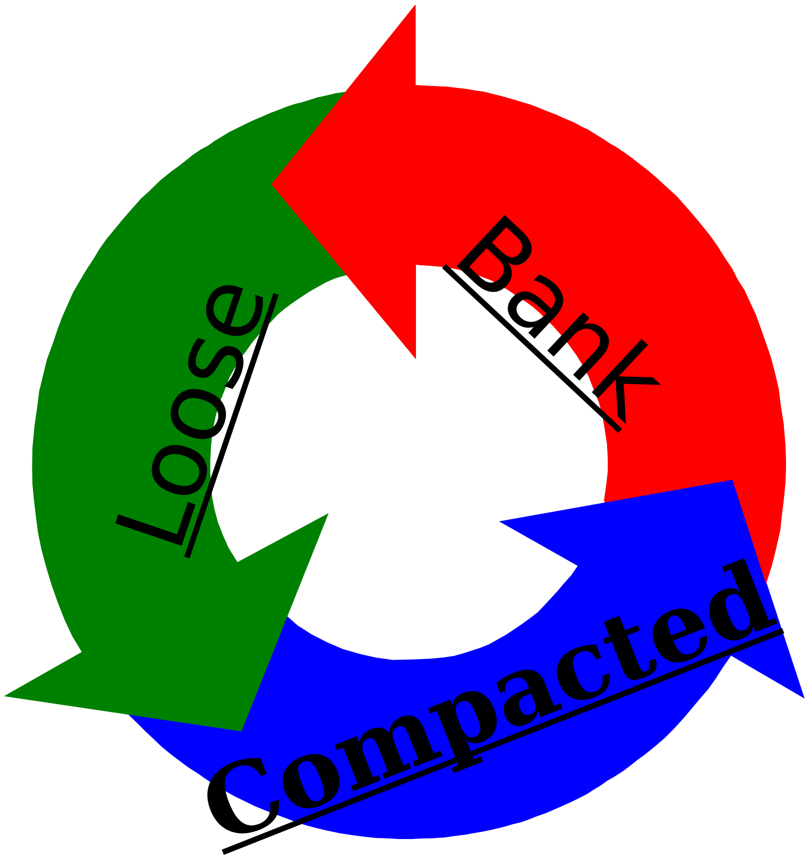
Type Unit	***Operator***	***Day***	***Night***
Tracked	Excellent Average Poor	1.00 .75 .60	.75 .56 .45
Wheeled	Excellent Average Poor	1.00 .60 .50	.67 .40 .33

- Example:
  - What is the hourly production rate for a 621B with an average operator, working days, making 3.49 TPH, with a load of 17.5 LCY?

3.49 TPH x 17.5 ALS x .60 = 36.65 or 36 LCYPH

Scraper Production Step #13

- ***Soil Conversion (SC) (if needed)***
  - in some cases the hourly production rate may be needed in compacted cubic yards (CCY) for a road or runway.
  - Note: round down CYPH.



Scraper Production Step #14

- ***Total Hours Required To Complete Mission***
  - To determine the total time required to complete the mission, you must know the total volume to

- Volume needed (_CY)

  _CYPH x #of scrapers =

  Total Hours Required
- Note: never round off time.

- Example:

  19,440 CCY

  25 CCYPH x 3 scrapers =

  259.20 hours required

Scraper Production Step #15

- ***Total Production Days***
  - To get the production days required to complete the mission, divide total hours required by the hours worked

- Example:

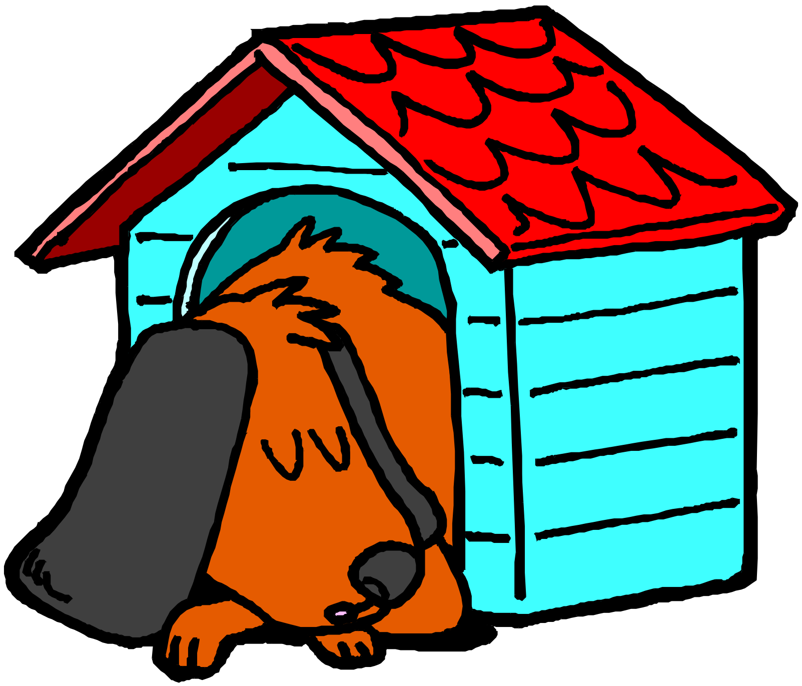
  259.20 hours req. ÷ 8 hrs/day

  = 32.40 or 33 days

- Note: Round days to next full day.

What Have You Learned?

- *Problem# 16*
- Figure total number production days with the following factors:
  - 3 621B
  - – Struck loaded, loam
  - 7 hr. production day
  - – Excellent operator
  - 13.08 min. cycle time
  - – Compacted volume required for job 250,000 CY
  - – Working 60 min/hr



Solution

- Step #11

  60 Min/hr
  ÷13.08 CT
  4.59 TPH

- Step #12

  4.59 TPH
  x 14 ALS
  x1.0 Efficiency factor
  64.26 or 64 LCYPH

- Step #13

  64 LCYPH
  x.72 Conversion Factor
  46.08 or 46 CCYPH

- Step #14

  250,000 Req vol
  46 x 3 =
  1,811.59 hrs

- Step #15

  1,811.59 hrs req

What Have You Learned?

- ***Problem #17*** **A project requires you to build a parking lot using gravel. How many work nights, at 8 hours per night, are require to complete the project? You are working only during hours of darkness. The job conditions are as follows.**
  - 5 621B, Compacted fill required 150,000 **CY**
  - – Struck loaded, Gravel, moisture content 14%
  - – Haul distance 7000 ft, return same route
  - – Grade of haul road 6% downhill, Average operator
  - – Rutted, dirt roadway, with no stabilization under 4” to 6” penetration

Solution

- Step #1

  3000

  X 1.14

  3420 ASW

- Step #5

  3420 ASW

  x 14 ALS

  47,880 LW

- Step #6

  47880

  +66590

  114470

  ÷ 2000

  57.24 **ST**

- Step #7

  57.24

  x 150

  8586 **RR (HAUL)**

Solution

- Step #7

  33.30

  X 150

  4995

  RR(RETURN)

- Step #8

  57.24

  x 20

  x -6

  -6868.8 or 6869

  GA (haul)

- Step #8

  33.30

  x 20

  x 6

  3,996 GR

  (RETURN)

- Step #9

  8586 RR

  -6869 GA

  1717 **RPP (HAUL)**

  8TH 26MPH

Solution

- Step #9

  4995 RR

  +3996 GR

  8991 RPP(RETURN)

  5TH 11MPH

- Step #10

  7000’

  26 x 88 = 3.06 **HT**

- Step #10

  7000’

  11 x 88 = 7.23. **RT**

  3.06 + 7.23 + 3.00 = 13.29

- Step #11

  60 **Min/HR**

  ÷13.29 **CT**

  4.51 **TPH**

Solution

- Step #12

  4.51 TPH

  x 14 ALS

  <u>x .4</u> EFF. FAC.

  25.26 or 25 LCYPH

- Step #13

  25 LCYPH

  <u>x .86</u> Conv. Fac.

- Step #14

  <u>150000</u>

  21 x 5 = 1428.57 **THR**

- Step #15

  1428.57 THR

  <u>÷ 8</u> **HRS/NIGHT**

  178.57 or 179 **NIGHTS**

QUESTIONS

a. **How many steps are there in Scraper production?**

15

b. **When do you round off time?**

NEVER

c. **What does TPH mean?**

Trips Per Hour (TPH)

BREAK 10 MIN

Push Loading

- One of the most effective methods of loading a scraper.
- Decreases time, and distance.
- Usually, a 621B is pushed by a MCT.
- The MCT has a reinforced blade for push loading.
- Load time should be 1 min. or less.
- The optimum loading distance is around 90’ - 125’.
- The optimum depth of cut is 4” - 6”.
  - Varies according to type of soil,moisture content, loadability, operator, load size,and method of employment.

Push Loading

- Normally the gear used during push loading is second for the MCT and first for the 621B.
- The Mph listed In table #5-2 for the scraper and table #8-2 for the MCT reflect maximum and/or average speed in mph.
- When push loading is employed, the maximum mph will not be the loaded mph reflected in the tables, therefore, **<u>for classroom purposes, use 2 mph when push loading.</u>**

Push Tractor Step #1

- Figuring the number of push tractors (PT) needed.
  - ***Load Time (LT)***
  - The time required to load the haul unit during which the dozer is in contact with the

- Length of cut

  mph x 88 = LT in min.

- Example:

  150’ length of cut

  2 mph x 88 = .85 LT

Push Tractor Step #2

- ***Boost Time (BT)***
  - The time expended after the scraper is loaded during which the push tractor assists the scraper in attaining momentum. (for boost time use a constant of .25)

Push Tractor Step #3

- ***Return Time (RT)***
  - the time required for the push tractor to return to the starting point.
  - This portion of the cycle time will be greatly reduced by chain

- LT x 1.4 = RT
- Example:

.85	LT
x 1.4	Constant
1.19 min.	RT

Push Tractor Step #4

- ***Formulate Cycle Time***

  (Load Time x 1.4) + Boost Time = PT Cycle Time (CT)

- Example:

  (.85 x 1.4) + .25 = 1.44 min PT CT

  NOTE: NEVER ROUND OFF TIME

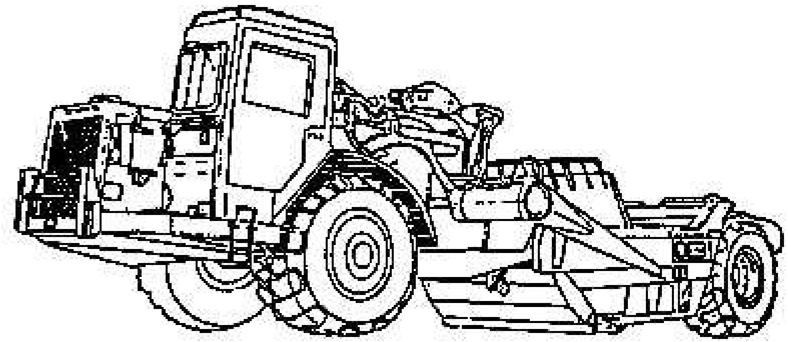
Push Tractor Step #5

- ***Number Of Scrapers A Push-Tractor Can Support***
  - This is found by dividing scraper cycle time by the push-tractor time.
  - **Example:**
  - How many scrapers can a single push-tractor support if the scraper cycle time is 4 min. and the push-tractor cycle time is 1.3 min ?

- 4 min Scraper CT

  ÷1.3 min PT CT

  3.08 Round down to 3



Push Tractor Step #6

- ***Number of Push-Tractors Required***
  - This is found by dividing the number of scrapers on the job, by the number of scrapers a push-tractor can support

- Example:
  - How many push-tractors are required on a job that has 9 621B's, if a single push-tractor can support 3 scrapers?

    9 Scrapers

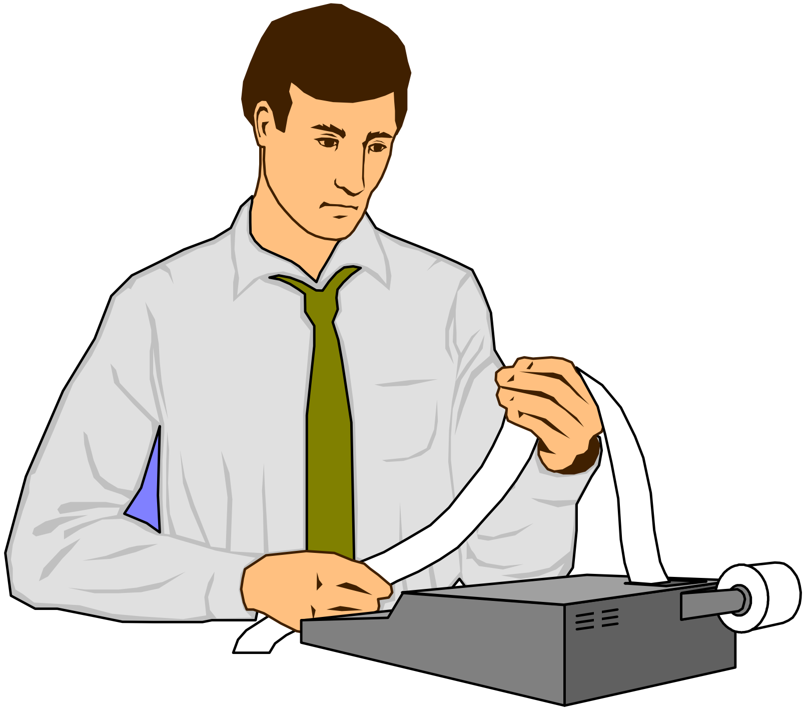
What Have You Learned?

- ***Problem #1***
  - Figure the number of push-tractors required for :

4 621B

12.58 min cycle time

150’ cut



Solution

- Step #1

  Step #4

  1.19 PT

  150 ft Length of cut

  + .25 BT

  ÷ (2 x 88) mph & conv.factor

  1.44 min PT CT

- Step #5

  .85 LT

  12.58 CT

- Step #2

  ÷1.44 PT CT

  .25 BT

  8.74 or 8 Scrapers/PT

- Step #3

  .85 LT

Solution

- Step #6

    4 Scrapers

    $\underline{\div\ 8}$ Scrapers/PT

    .50 or 1 PT required

What Have You Learned?

- ***Problem #2***
  - – Figure the number of push-tractors required for:

7 621B's

8.92 CT

125' Cut

Solution

- Step #1

  125 Length of cut

  ÷(2x88) mph & conv. Factor

  .71 LT

- Step #2

  .25 BT

- Step #3

  .71 LT

  x 1.4 Conv. Factor

- Step #4

  .99 RT

  +.25 BT

  1.24 min PT CT

- Step #5

  8.92 CT

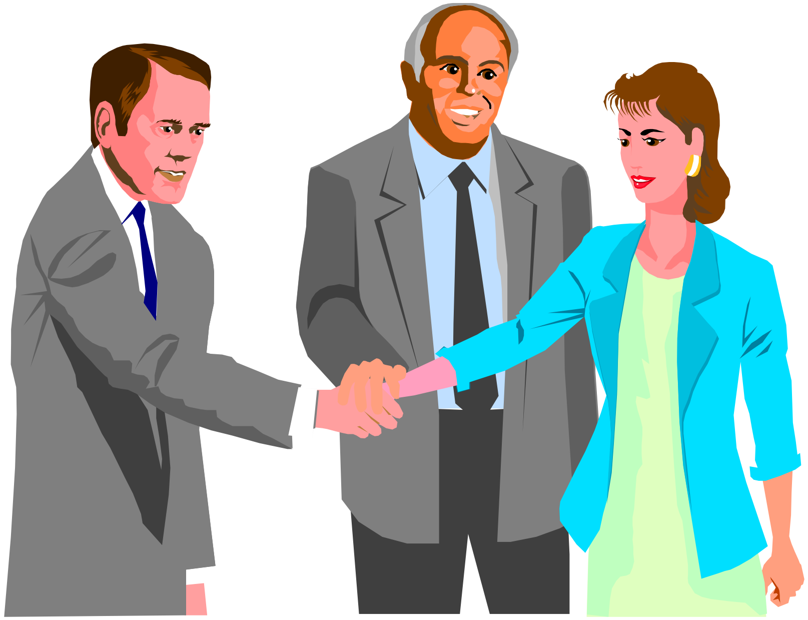
  ÷1.24 PT CT

  7.19 or 7 Scrapers/PT

Solution

- Step #6

$$\begin{array}{rl} 7 & \text{Scrapers} \\ \underline{\div\ 7} & \text{Scrapers/PT} \\ 1 & \text{PT required} \end{array}$$



What Have You Learned?

- ***Problem #3***
  - A project requires you build a road using clay and gravel with an 8% moisture content.
  - The borrow pit area allows you to push load the 621Bs with MCTs.
  - How many days are required?
  - Show and label all figures and formulas.

Solution

- Days
- Step #1
  2,916 ASW
- Step #2
  14 CY/load
- Step #3
  N/A
- Step #4
  N/A
- Step #5
  40,824 LW
- Step #6
  – Haul
  107,414 GW
  53.71 ST
  – Return
  33.30 ST
- Step #7
  – Haul
  5,371 RR
  – Return
  3,330 RR
- Step #8
  – Haul
  7,519 GR
  – Return
  4,662 GA

Solution

- Step #9
  - Haul

    12,890 REQPP

    4th gear 8 mph
  - Return

    -1,332 REQPP

    8th gear 26 mph
- Step #10

  9.38 HT

  2.88 RT

  13.99CT
- Step #11

  4.29 TPH
- Step #12

  36 LCYPH
- Step #13

  22 CCYPH
- Step #14

  1,325.76 Hrs Req
- Step #15

  133 Days

Solution

- Step #5
  # of PT Required
  15 #scrapers/dozer
- Step #6
  1 PT required
- Step #1
  .45 BT
- Step #2
  .25 BT
- Step #3
  .63RT
- Step #4

QUESTIONS

a. **What is the only dozer in the Marine Corps that can be used as a push tractor?**

   Medium Crawler Tractor (MCT)

b. **What are the three types of push loading??**

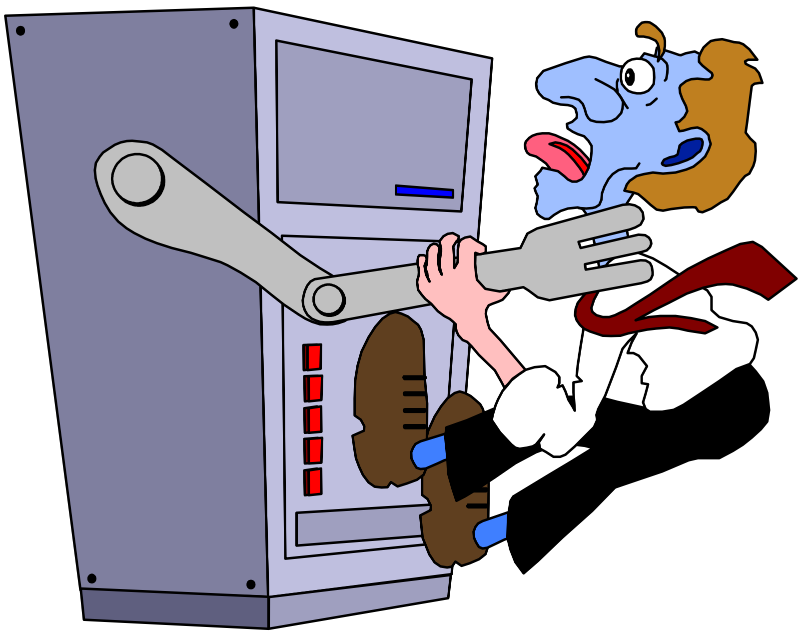
   Chain Loading, Shuttle Loading, Backtrack loading

c. **What should the load time be?**

   One minute or less

Push Tractor Production

- Take A Break!



Crawler Tractor

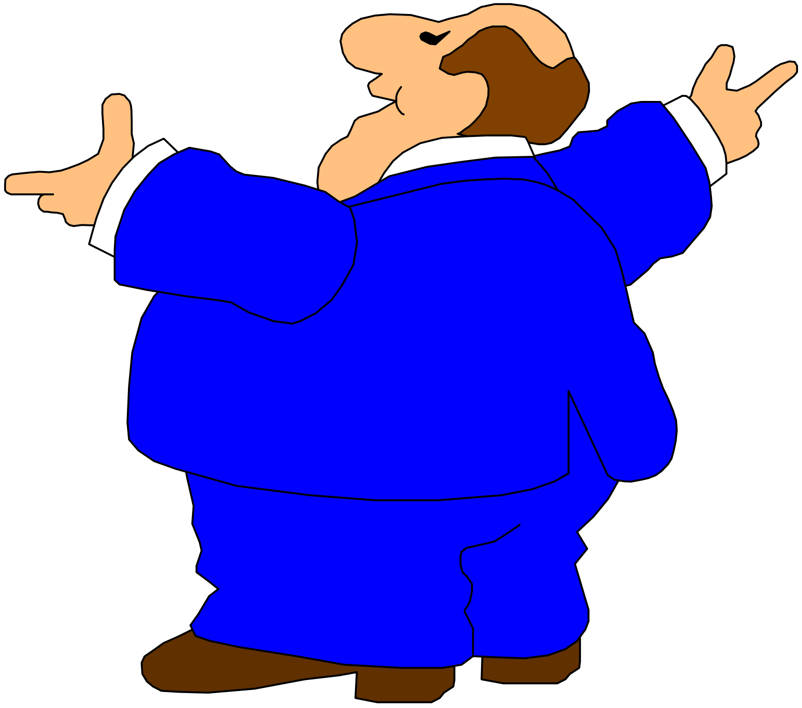
- Introduction
  - Dozers and scrapers are the most common pieces of equipment on a project.
  - It is important to be able to properly use these earthmovers to, get maximum production, to establish production estimation rates, and to insure the prompt completion of an earth moving task.

Dozer Uses

- Used as prime movers for pushing or pulling loads.
- Used for power units for winches and hoists.
- As moving mounts for dozer blades.
- Used primarily where it is advantageous to obtain high drawbar pull and traction.
- Most suitable equipment for pushing or pulling loads through marshy areas.

Dozer Classification

- Crawler tractors are classified according to weight.
  - Light (1150 & 1155)
  - Medium (MCT)
  - Heavy (D8)



Dozer Characteristics

- Supported on the ground by track assemblies.
- Commonly called bulldozers, they are the work horses of construction.
- Usually the first piece of equipment on job site, last to leave.
- Used to cut haul roads, move dirt, trees, rocks, and many other.
- Simply a tractor with a blade mounted on the front which is used for pushing objects or materials.

Dozer Characteristics

- Once the blade is removed, it’s used as a towing unit.
- Since the weight of the machine is supported by the track sections, the crawler tractor has great traction pull.
- The ability to “lock” one side section of track while pulling with the other one enables the crawler tractor to pull itself out of material that would easily cause a wheeled machine to become stuck.

Dozer Operation

- Equipped with a diesel engine rated from 85 to 202 horsepower, and either 4 or 6 cylinders, depending on make and model.
- Low ground bearing pressure, varying form 6 - 9 lbs./Sq. in., which gives it distinct “floatation” advantage.
- Capable of operating in muck or water as deep as the height of the track.
- Can move to jobsite on own power, but transporting is preferred.

Dozer Production

- Estimated using the production from Table #9-3, and then adjusting the table with six correction factors.

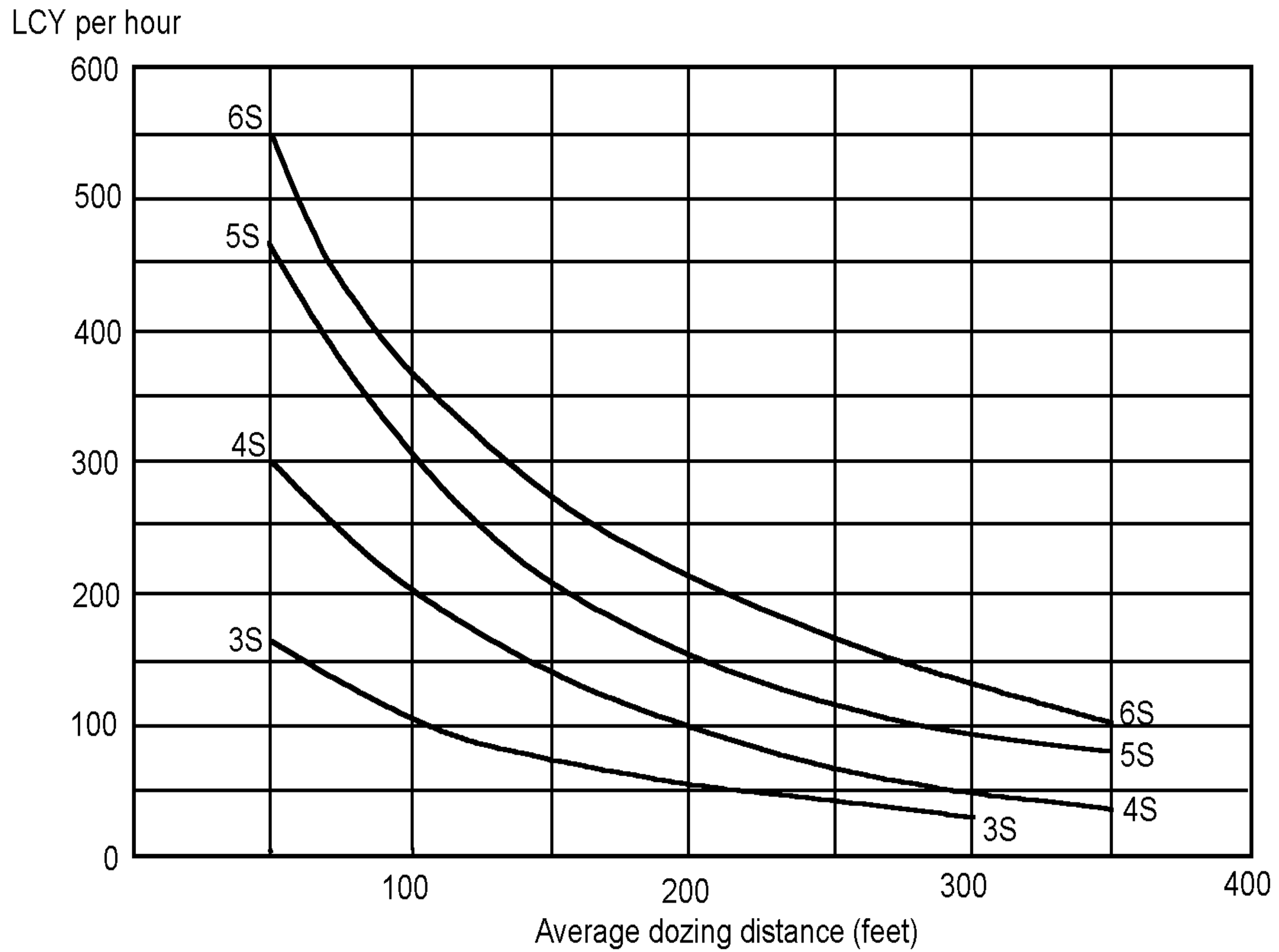
Dozer Production

- Formula
  - Factor 1 x Factor 2 x Factor 3 x Factor 4 x Factor 5 x Factor 6 = LCYPH
- Note: Round down LCYPH
- For classroom purposes, if you are not given the information for any step, that step will be N/A.

Dozer Production Factor #1

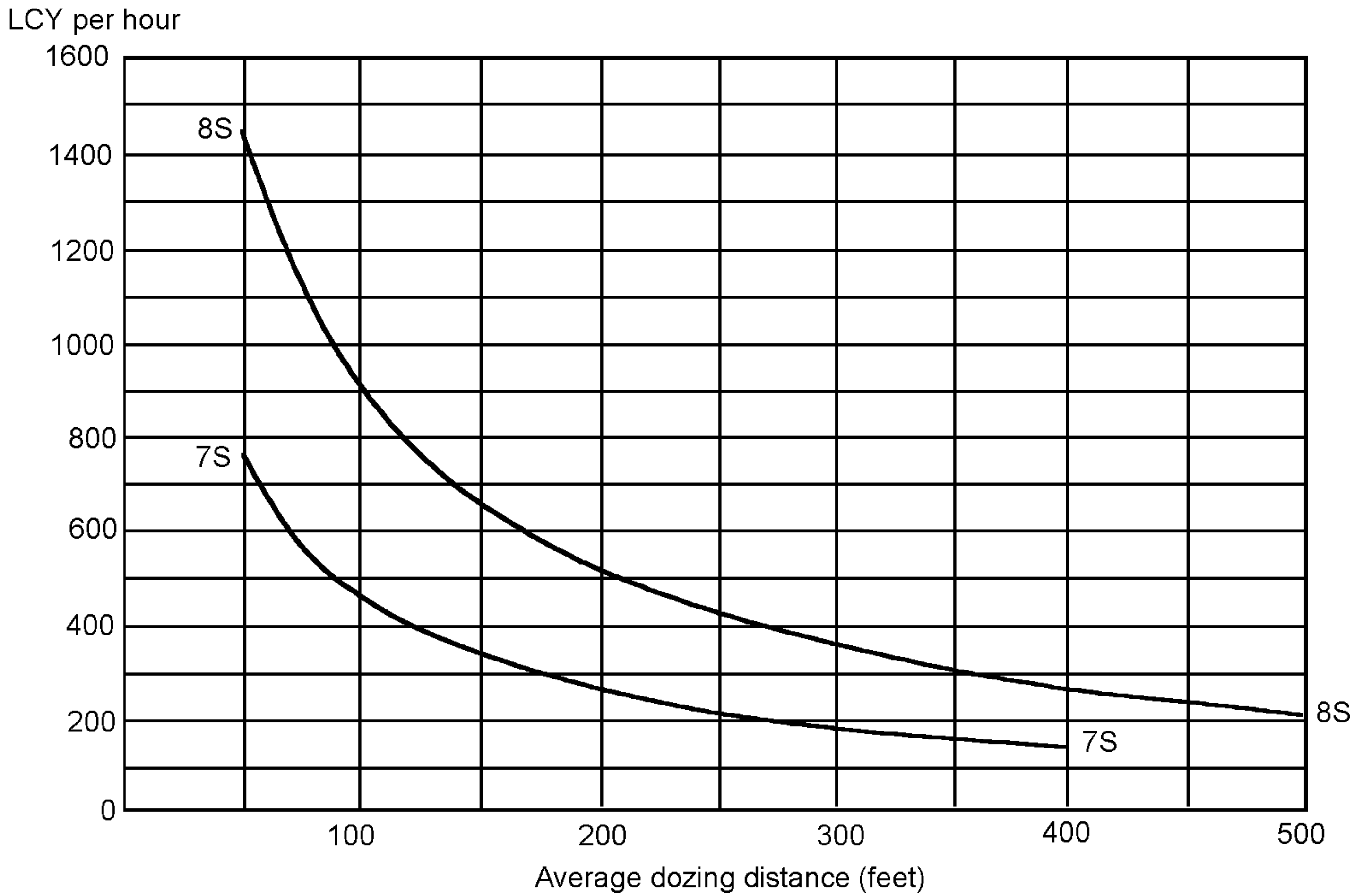
- ***Maximum Basic Production***
  - Find the average dozing distance line on the bottom of the scale.
  - Read up until you intercept the production curve for the dozer you are using.
  - Then read to the left to get the production rate in LCYPH.
- Note:
  - On the charts the **4S** is the 1150E and the **7S** is the MCT.
- Example
  - Determine the maximum basic production for a MCT with an

Dozer Production Factor #1



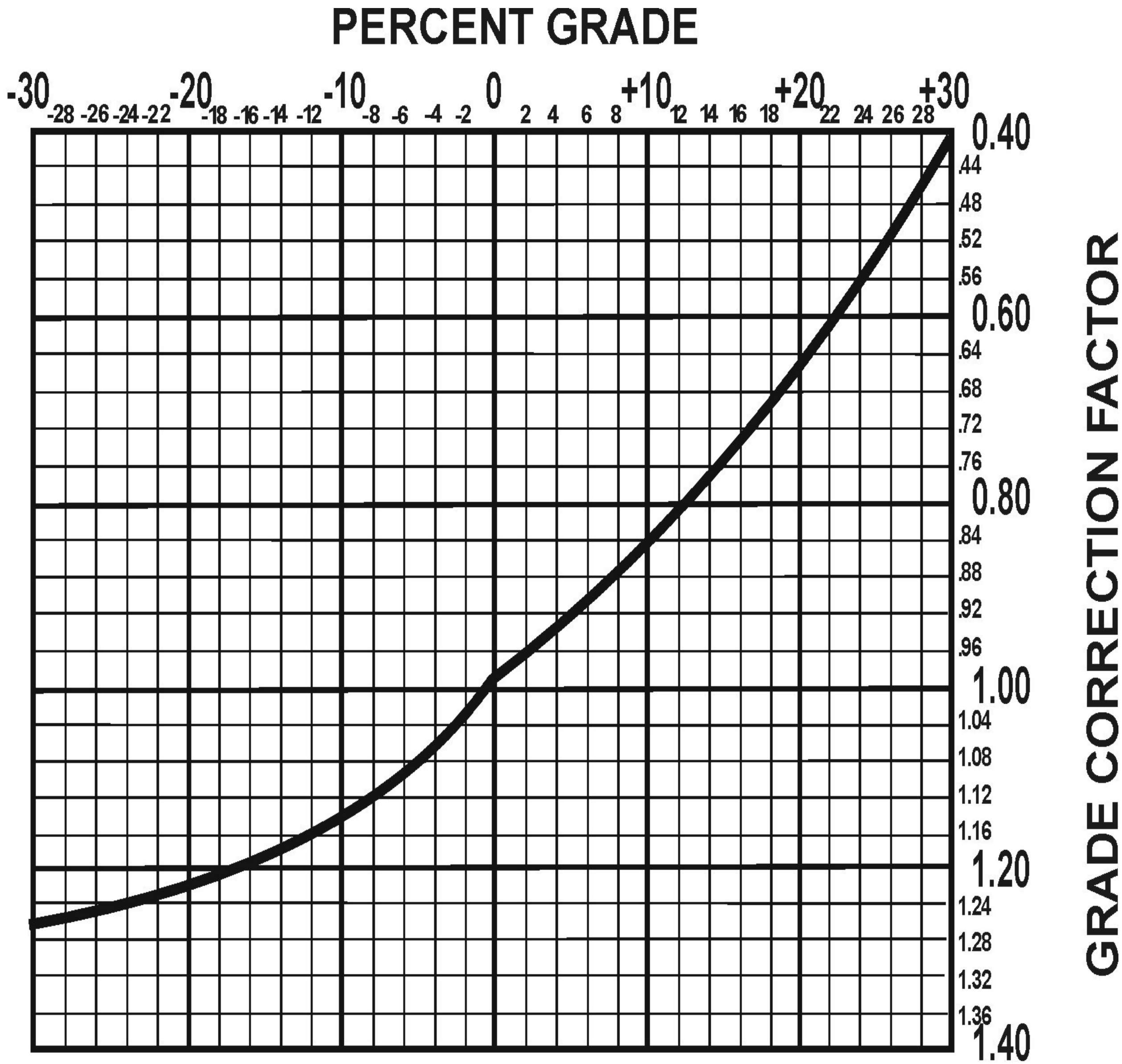
Dozer Production Factor

"1



Dozer Production Factor #2

- ***Grade Correction Factor***
  - Using table #10-3 find the % of grade (-) favorable, (+) unfavorable, on the top of the scale, read down until you intercept the grade correction curve.
  - Read to the right to determine the grade correction factor.
  - Each vertical line on this scale represents multiples of two.
  - Each horizontal line represents 0.04.
  - Note: For classroom purposes round off, up or down to the closest factor.


PERCENT GRADE
-30
-28 -26 -24 -22
-20
-18 -16 -14 -12
-10
-8 -6 -4 -2
0
2 4 6 8
+10
12 14 16 18
+20
22 24 26 28
+30
0.40
.44
.48
.52
.56
0.60
.64
.68
.72
.76
0.80
.84
.88
.92
.96
1.00
1.04
1.08
1.12
1.16
1.20
1.24
1.28
1.32
1.36
1.40
GRADE CORRECTION FACTOR

Example

- If you had to move the material up a 2% grade (+), what would be your grade correction factor?

  .96

Dozer Production Factor #3

- ***Soil Weight Correction Factor***
  - Using table #2-2 as before, get your ASW.
  - Divide 2,300 lbs./CY by you ASW to find the correction factor.

    2,300 lbs. is a constant which is the weight of soil used to determine table #9-3.
- Example:
  - You are working in clay with a 5% moisture content.

2,300	Constant
÷2,100	ASW
1.10	Soil weight correction factor

Dozer Production Factor #4

- Soil Type Correction Factor
  - The dozer blade is designed to cut the material and give is a rolling effect for a production factor of 1.00.
  - Material found in different states will effect dozer production as in the following table.

Table # 11-3 **Soil Correction Factor**

Soil Type	***Factor***
Loose, Stockpile	1.20
Hard to cut (with tilt cylinder)	0.80
Hard to cut (without tilt cylinder)	0.70
Hard to Drift (sticks to blade)	0.80
Rock, Ripped or Blasted	0.60

Dozer Production Factor #5

- ***Equipment/Operator Efficiency Correction Factor***
  - These factors include operator efficiency and visibility (dust, rain, snow, fog, and darkness) with a job efficiency of a 60 min. hour.

Table #7-2 Equipment/Operator Efficiency Factor

Type Unit	*Operator*	*Day*	*Night*
Tracked	**Excellent**	1.00	0.75
	Average	0.75	0.56
	Poor	0.60	0.45

Dozer Production Factor #6

- ***Management Technique Correction Factor***

Table #12-3

Management Technique	***Factor***
Slot Dozing	1.20
Side By Side Dozing	1.15

Dozer Production Step #1

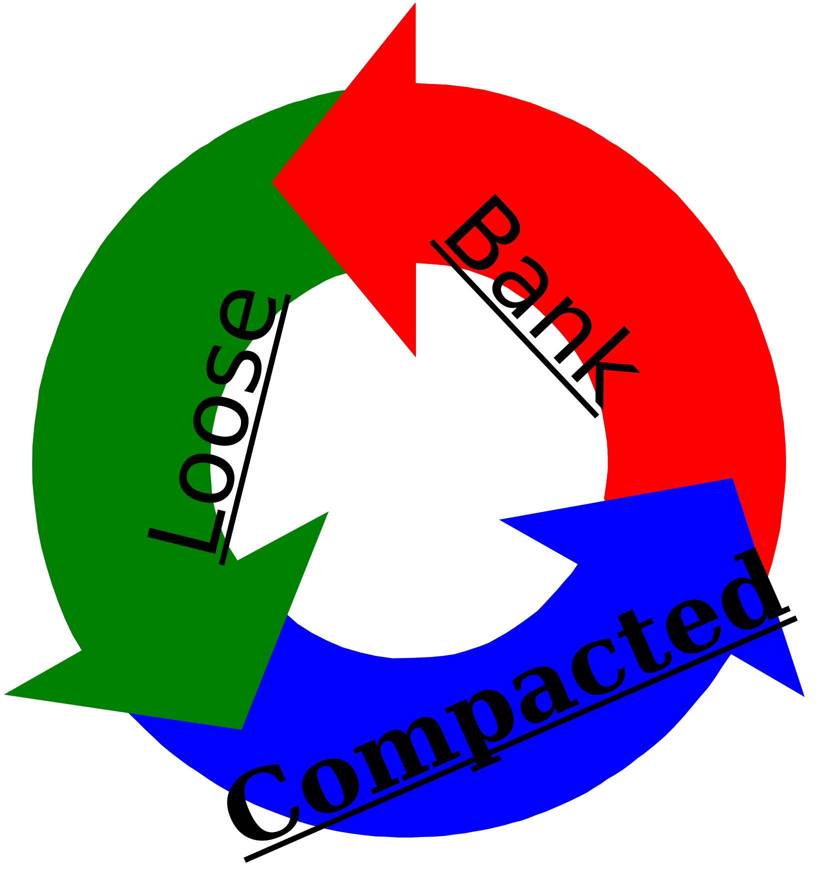
- ***Production Calculation***

  Factor #1
  x Factor #2
  x Factor #3
  x Factor #4
  x Factor #5
  x Factor #6
  LCYPH/dozer

- Note: Round down LCYPH

Dozer Production Step #2

- ***Soil Conversion Factor (if required)***
  - Convert soil by using table #1-1 as before.



Dozer Production Step #3

- ***Total Hours Required***
  - Quantity to be moved, divided by the hourly production rate, multiplied by the number of dozers you have employed, equals the total

- Example:
  - How long would it take to move 4,500 CCY of clay, using 3 MCTs with a production rate of 143 CCYPH?

4,500 CCY

÷(143x3) Basic prod. Rate x # dozers

10.49 hrs.

Dozer Production Step #4

- Total Production (Days)

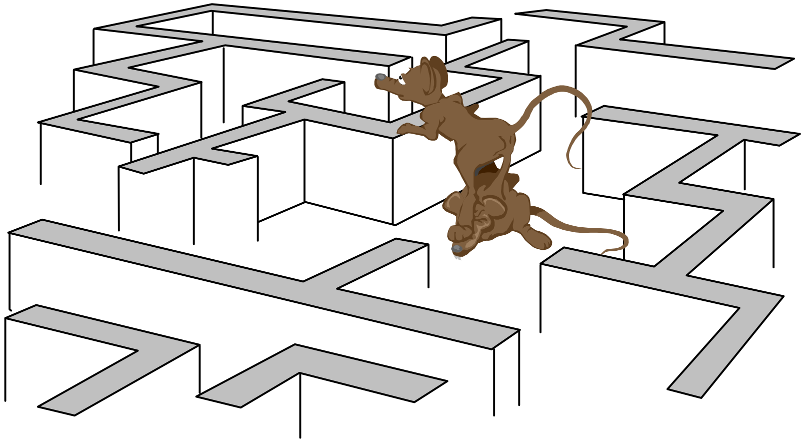
- Example:

  10.49 Hrs required

  ÷ 8 Hrs/day

  1.31 or 2 Days

- Note: round days to next full day.



Dozer Production Step #5

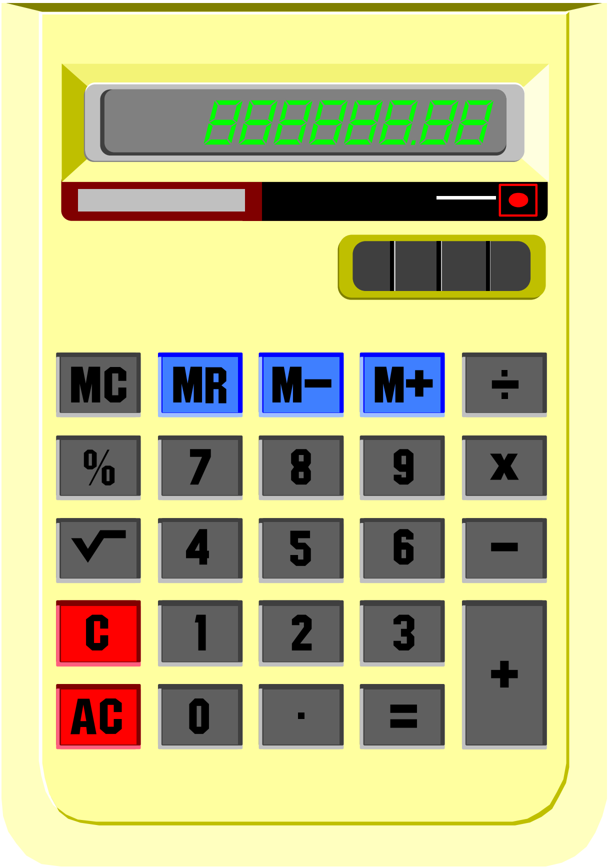
- Total Number of Dozers Required
  - Quantity of material to be moved.
  - Divided by the hourly production rate.
  - Multiplied by the number of hours you have to complete the job.

- Example:
  - How many MCTs would be needed to move 4,500 CCY of loam in 5 hrs. if the dozers have a hourly production rate of 143 CCYPH?

4,500 CCY required

What Have You Learned?

- ***Problem #1***
  - Using the information in your handout, determine how long it will take 2 MCTs to complete the job:



Solution

- Factor #1
  300 LCYPH Max. basic prod.
- Factor #2
  .96 Grade correction factor
- Factor #3
  2,040 ASW
  1.13 Soil wt correction factor
- Factor #4
  .80 Soil correction factor
- Factor #5
  .45 Equip/Op correct. factor
- Factor #6
  1.15 Mngt. correct. Factor
- Step #1
  134.73 or 134 LCYPH
- Step #2
  84.42 or 84 CCYPH
- Step #3

What Have You Learned?

- ***Problem #2***
  - Using the information in your student handout, determine how many MC1150Es are required to complete the job in 5 hours.

Solution

- Factor #1

  200 LCYPH Max. basic prod.

- Factor #2

  .92 Grade correction factor

- Factor #3

  2200 ASW

  1.05 Soil wt correction factor

- Factor #4

  .80 Soil correction factor

- Factor #5

  1.00 Equip/op correct. factor

- Factor #6

  1.20 Mngt. Correct. factor

- Step #1

  185.47 or 185 LCYPH

- Step #2

  N/A

- Step #3

  3.22 or (4)

Dozer Production Estimation

- Are there any questions?
- Take a break!

PRODUCTION ESTIMATIONS
LOADERS

Scoop Loader Production

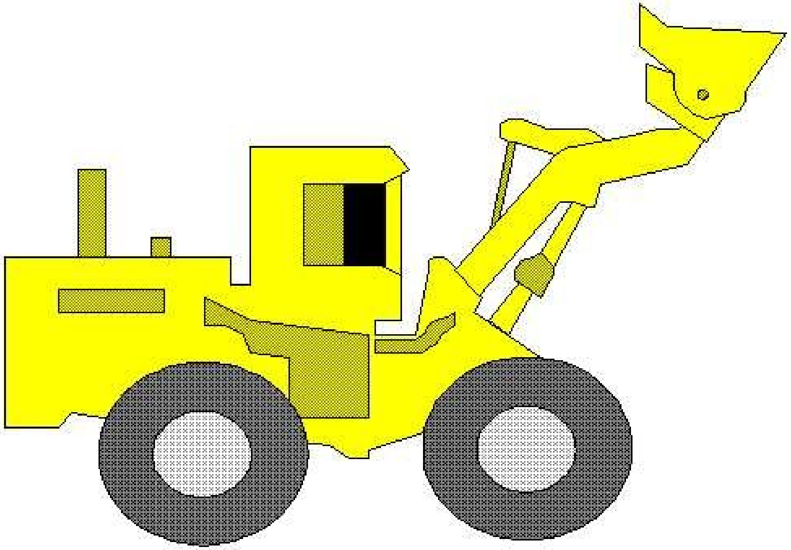
- Introduction
  - Loaders are available in varied sizes and bucket capacities.
  - Loaders have a hinged frame which provides the steering, this steering method is referred to as articulated, and provides greater maneuverability.
  - Articulated steering provides zero clearance for personnel at the point of articulation.
  - Most loaders have a towing pintle for towing small trailers.
  - Special caution should be exercised when the bucket is fully raised, because the chances of rollover or tipping are greatly increased

Production Estimation

- Uses
  - Primarily used for front end loading.
  - Also used for excavating, snow removal, and back filling.
  - It is capable of many other operations with the proper attachments such as; forks, sweeper, snowplow, and multi segmented bucket.
  - Used around rock quarries, when equipped with rock-type tread tires.
  - Used in various tasks, including, stripping overburden, charging hoppers, and carrying materials.

Production Estimation

- Classification
  - Classified according to bucket size.
  - Normal bucket sizes are 2½ and 5 cubic yards.



Production Estimation

- Characteristics
  - Wheeled vehicles characterized by an attachment for lifting and loading.
  - Most common scoop loader attachments are the shovel type bucket and the forklift.
  - Hydraulically operated.
  - Two types of buckets: the general purpose and the multi-segmented bucket.
  - The GP is a one piece bucket made of

Production Estimation

- The multi-segmented bucket is a hinged jaw bucket, commonly referred to as a clamshell.
- The two piece bucket has many capabilities not available to the single piece.
- These include, clamshell, dozer, and scraper operations.

Production Estimation

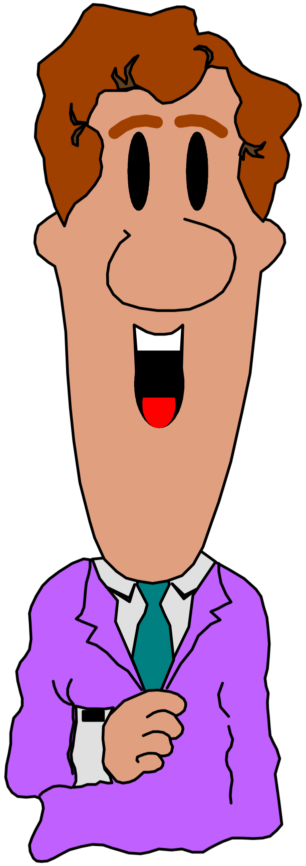
- Operation
  - Hydraulically operated and powered by a diesel engine.
  - Extremely versatile and capable of many operations.
  - When working in a stockpile, the bucket should be parallel to the ground when loading and raised after penetration.
  - Crowding the material will prevent spilling, and maximize loading.
  - When loading trucks the “V” method should be used.
  - A loader can dig excavations such as defilades and gun emplacements.

Production Estimation

- Production
  - Scoop loaders are affected by numerous factors which must be considered prior to their employment.
  - Among these factors are:
  - Operator skill
  - Extent of prior loosening of material
  - Weight and volume of the material
  - Slope of the operating area
  - Height of material
  - Climatic conditions
  - Management factors.

Production Estimation

- The Marine Corps has 2 scoop loaders in the system.
  - MC1155E
  - 624KR TRAM
  - The 420DV can also be used.
- Estimating using the following formula:



Production Estimation

- Step #1: ***Determine Basic (Maximum) Production***
  - Bucket size (CY) x Secs. working/hour

    Loader cycle time (Secs.)

    =

    Basic Production (LCYPH)
  - Note: you can find the seconds you are working per hour by multiplying the minutes you are working per hour by 60.
  - Example:

    $$\frac{2.5 \times 3{,}600}{35} = 257.14 \text{ or } 257 \text{ LCYPH}$$

Production Estimation

- Step #2: ***Determine Efficiency Factor (Table 17-5)***
  - Efficiency depends on both job conditions and management conditions.
  - To arrive at an efficiency factor, these conditions must be subjectively evaluated.
  - Job Factors - the physical conditions that affect the production rate of specific jobs, other than the type of material to be handled.

Production Estimation

- *Job Factors to Consider:*
  - Topography and work dimensions, including depth of cut and amount of movement required.
  - Surface and weather conditions, including the season of the year and drainage conditions.
  - Specifications that control handling of work or indicate the operational sequence.
  - Equipment maintenance, and directing personnel.

Production Estimation

- *Management Factors to Consider:*
  - Planning, organizing, and laying out the job; supervising and controlling the operation.
  - Selecting, training, and directing personnel.

Production Estimation

Table #17-5   Management Factors

Job Factors	Excellent	Good	Fair	Poor
Excellent	.84	.81	.76	.70
Good	.78	.75	.71	.65
Fair	.72	.69	.65	.60
Poor	.63	.61	.57	.52

Production Estimation

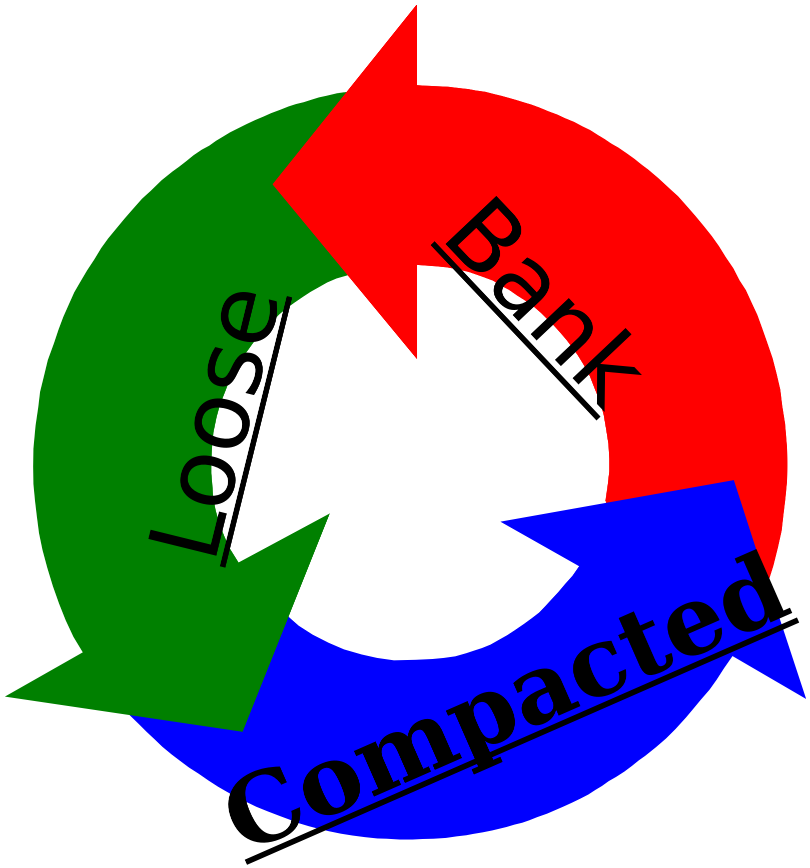
- Step #3: Determine Net Production (LCYPH)
  - To determine the net production in LCYPH, multiply the basis production in LCYPH by the efficiency factor.

- Example:
  - What is the NET production in LCYPH of a scoop loader with a basic production rate of 257 LCYPH, and an efficiency factor of .71?

257 LCYPH

Production Estimation

- Step #4: Soil Conversion (If Needed)
  - If your requirement, or quantity to be moved, is expressed in either CCY or BCY, you must convert your net production.



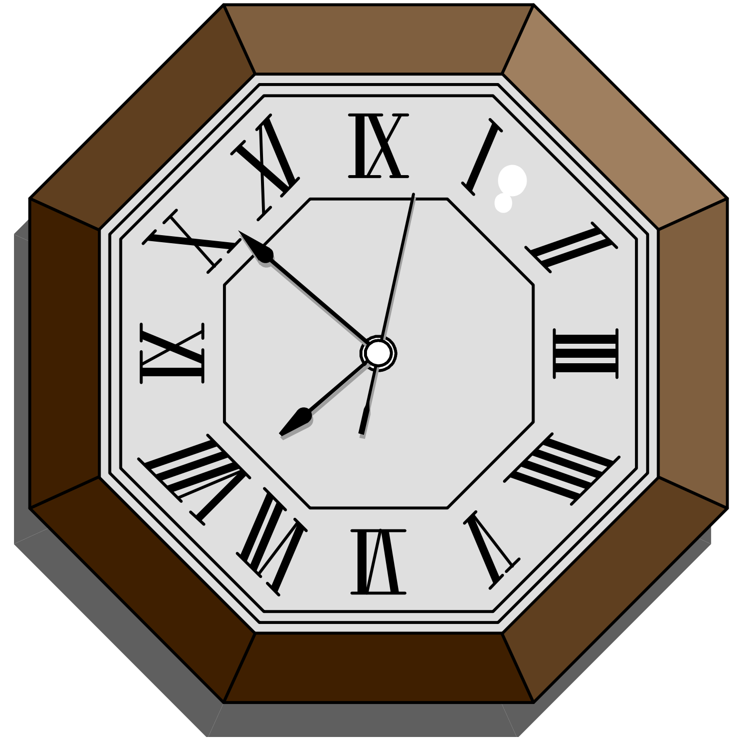
Production Estimation

- Step #5: ***Total Time Required (HRS)***
  - Determine the total time required to complete the mission.
- Qty. to be moved

  Hrly prod rate x # of loaders =

  Total Time (hrs)

  Never round off time

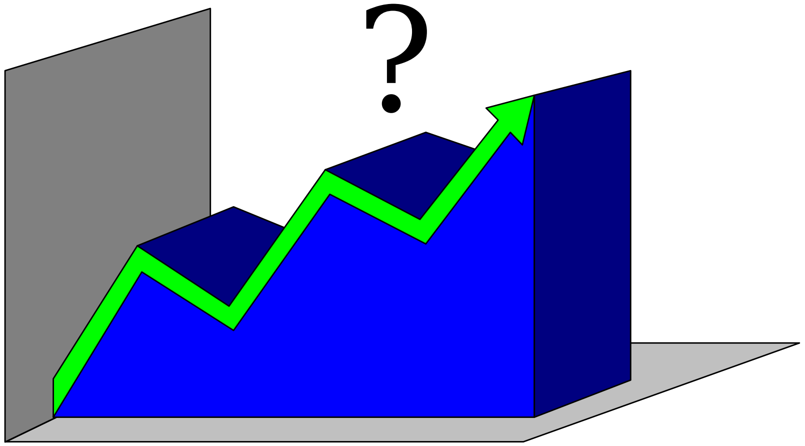


Production Estimation

- Step #6: Total # of Days Required
  - Determine the total # of days the project will take.

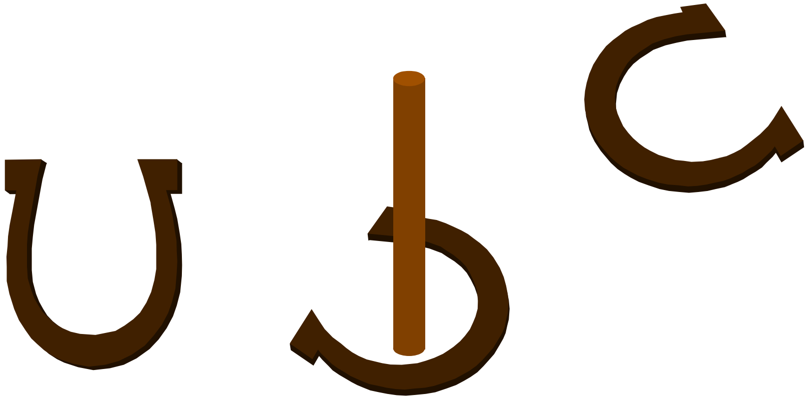
  # hrs req
  # hrs wk/day = # days

  Note: round up to the next full day



Production Estimation

- What have you learned?
- Problem #1
- Problem #2



Solution #1

- 2.5 BUCKET SIZE

x 3,600 SECS/HR Worked

9,000

÷ 120 LOADER CT

75 LCYPH

x .65 EFF FAC

48.75 or 48 LCYPH

x .72 CONV FAC

34.56 or 34 CCYPH

Solution #2

- 1.75 BUCKET SIZE

x 2,700 SECS/HR Worked

4,725

÷ 90 LOADER CT

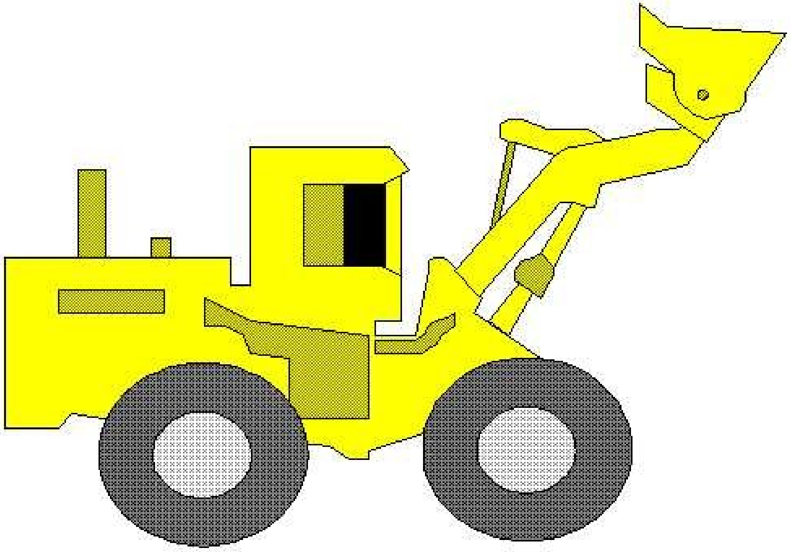
52.50 or 52 LCYPH

x .52 EFF FAC

27.04 or 27 LCYPH

Production Estimation

- Ratio of Loading Units to Hauling Units
  - You need to determine how many loaders is required to keep up with the haul units.



Production Estimation

- Use the following formula to figure out how many haul units 1 loader can handle **with no waiting.**

  Haul Unit Cycle Time

  Load Time (Table #18-5) = # haul units/loader

- Note: Round down # of haul units.

Table #18-5 Loading Time

Loading Equipment	621B Struck	621B Heap
1155E	6 min.	8 min.
Tram 644E	5 min.	6 min.
420D IT ***4 in 1 Bucket*** ***GP Bucket***	 11 min. 15 min.	 15 min. 21 min.
ATC - ***Clamshell***	15 min.	18 min.

Production Estimation

- Notes:
  - If the actual load size falls between a struck and a heap load, use the heap load time for the load time.
  - These are average fixed times only and are based on an average operator who is familiar with the attachments and equipment operation.
  - These times are a basic starting point only.
  - Actual fixed times can vary considerably due to varying conditions.
  - Timing of several actual cycles is necessary in

Production Estimation

- Example:
  - How many haul units can 1 Tram handle, if the haul units are hauling 15 CY of material and their cycle time is 14.5 minutes?

$\underline{14.5}$

6 = 2.42 or

- Next you need to determine the total number of loading units needed.
- All you would need to do is divide the number of haul

Production Estimation

- Total Number of Loading units Needed:
  - Use the following formula:

$$\text{\# HAUL UNITS NEEDED} \div \frac{\text{HAUL UNIT CYCLE TIME}}{\text{LOAD TIME (TABLE\# 18-5)}} = \text{\# LOADING UNITS}$$

Note: Round up # loading units

Production Estimation

- What have you learned?
- Problem #3
- Problem #4

Solution #3

- 8.42 HAUL UNIT CT

  ÷ 5 LOAD TIME

  1.68 or 1 HAUL UNIT

Solution # 4

- 7 # Of HAUL UNITS

  ÷ 33 HAUL UNIT CT

  .21

  x 6 LOAD TIME

  1.27 or 2 LOADING UNITS REQUIRED

QUESTIONS

Production Estimation

- BREAK…..

Production Estimation Dump Truck

Production Estimation

- **Introduction:**
  - The most common hauling equipment used for military purposes are the 2½, 5, 7 (MK29 MK30),15 and 20 ton trucks.
  - The 2½ ton truck is capable of hauling 2½ cubic yards of material.
  - The 5 ton 5 cubic yards.
  - The 20 ton, used mainly at a quarry, carries 12 cubic yards.
  - This will vary according to the type of material being used.
  - Materials weighing more than 2,000 lbs./LCY will reduce load size.

Production Estimation

- **Uses:**
  - Primarily used to haul and deliver material.
  - Also used to transport troops and equipment in support of the unit mission.
  - Equipped with a towing hook and are a tremendous asset for moving equipment and trailers.
  - Trucks equipped with winches are valuable for recovery operations.

Production Estimation

- **Classification:**
  - Classified by weight they carry in tons, by truck volume in cubic yards, or by the heaped capacity in cubic yards.
  - For example a 5 ton truck can carry 5.88 cubic yards of loose dry clay weighing 1,700 lbs/LCY but is restricted to the 5 cubic yard capacity.
  - Wet clay weighing 3,200 lbs/LCY, for instance would be restricted by the 5 ton capacity.

Production Estimation

- Characteristics:
  - Characterized by a hydraulic lift cylinder that is used to raise and lower the bed.
  - Most trucks are capable of all wheel drive that permit operation in different terrain's.
  - The truck becomes top heavy when fully raised, so caution should be taken on side slopes.
  - For safest operation, the assistant operator should dismount and act as

Production Estimation

- **Operation:**
  - Hydraulically operated and powered by a diesel engine.
  - Haul at the highest speed possible, without speeding.
  - When several trucks are hauling it is essential to maintain proper speeds in order to prevent delays or bottlenecks.
  - Lay out traffic patterns in loading and dumping sites to minimize backing, passing, and cross traffic.
  - Keep trucks clean. The time spent cleaning and oiling truck bodies must be considered in

Production Estimation

- Operation (Cont.)
  - The 900 series dumps cannot raise the bed and move forward at the same time.
  - Where as the 800 series MK29 and MK30 dumps can, allowing them to spread the loaded material.
  - Dump truck capacities are expressed 2 ways:
  - Tons (Use Tables, #23-9, 1-3.1, 1-12.1 or check data plate for load weight.)
  - Cubic yards (Use Table 23-9 for CY or call motor transport)

Production Estimation

Table #23-9 Truck Volumes

Type of Truck	Load Capacity in lbs.	Struck Volume in LCY	Heap Volume in LCY
2½ Ton	5,000	Call MT for volume	Call MT for volume
5 Ton	10,000	5 LCY	7.5 LCY
20 Ton	40,000	Call MT for volume	Call MT for volume

- Note: Table information comes from TM 9 2320-260-10 and TM 9 2320-260-10

TABLE 1-12.1 Dump Body (MK29 and MK30)

Item	Specification
Struck Payload Capacity – Paved Surface	21,060 lbs (9,561 kg)
Heaped Payload Capacity – Paved Surface	28,000 lbs (12,712 kg)
Struck or Payload Capacity – Cross Country	14,200 lbs (6,447 kg)
Recommended Personnel Capacity	16 (NOTE: Also Refer to paragraph 2-31 for warning information)

NOTE: TABLE 1-3.1 AND 1-12.1 INFORMATION COMES FROM TM 10629-10B

Production Estimation

- **FOR CLASSROOM PURPOSES DO NOT EXCEED 10CY (20,000LBS) CAPACITY!**
- Outside the classroom, note the type of surface you are traveling on, this will change the capacity.

Production Estimation

- Production:
  - Other than scrapers, dump trucks are the primary haul units for earth work in the military inventory.
  - Generally used for hauling distances more than 5,000’.
  - There is ten steps to calculate dump truck production.

Production Estimation

- Step #1: ***Actual Soil Weight***
  - To determine the actual soil weight per cubic yard, take the dry soil weight from (Table #2-2).
  - If you are given a moisture content, multiply the weight of the soil dry by the moisture content.
  - This gives you your ASW in pounds.

Production Estimation

- Step #2: ***Cubic Yards Of A Load***
  - Remembering that you want to keep the weight of the load under 20,000 lbs., determine how many cubic yards can be hauled without exceeding 20,000 lbs.
  - To do this divide 20,000 by the ASW per cubic yard.

    20,000 lbs. (rated capacity)

    ÷2,354 ASW (step #1)

    8.50 CY or no more than 10 CY
  - If the resulting figure is over 10 cubic yards, you must go with 10.
  - If the resulting figure is less than 10, use that figure in step #3. (note: No more than the

Production Estimation

- Step #3: ***Buckets Loaded***
  - Determine the number of bucket loaded that is equal to or less than the figure determined in step #2. Divide that figure , in this case 8.50, by the size of each bucket load (Table #3-2) which for the TRAM is 2.5.

    8.50 CY

    ÷2.5 CY (bucket size from table #3-2)

    3.40 or 3 buckets

Production Estimation

- Step #4: ***Actual Load Size Or Volume***
  – To determine the volume of the load, take the answer from step #3, 1 bucket/load, and multiply by the bucket size (2.5 for a TRAM).

3	# of bucket/load
x 2.5	TRAM bucket size
7.5	Actual Load Size (ALS)

  – Note: Never round off load size or

Production Estimation

- Step #5: ***Load Weight***
  - Always try to keep your soil weight under 10,000 lbs.
  - Use Table #2-2 to determine you load weight.

    2,354 ASW (from step #1)

    x 7.5   ALS (from step #4)

    17,655 Load Weight (LW)
  - Now you know your load weight. You can now calculate your cycle time.

Production Estimation

- Step #6: ***Cycle Time***
  - Use Table #24-9 to get your travel speed.
  - The table is for classroom purposes only.
  - To figure cycle time you need to determine the travel time (TT).
  - To get TT divide the distance in feet by your travel speed (TS) multiplied by 88.
  - Do this for the haul and return to get your total cycle time.
  - Note: 88 is the conversion factor to change the speed in mph to feet per

Production Estimation

- Haul:
  - Distance in feet
    TS x 88 = Haul Time (HT)
- Return:
  - Distance in feet
    TS x 88 = Return Time (RT)
- HT + RT + 2 min. fixed time = CT
- Note: Use 2 min. as a constant fixed time for dump trucks in the

Production Estimation

- Example:

  Haul:

  $$\frac{7{,}500'}{35 \text{ TS} \times 88} = 2.44 \text{ HT}$$

  Return:

  $$\frac{8{,}200'}{50 \text{ TS} \times 88} = 1.86 \text{ RT}$$

  2.44 HT + 1.86 RT + 2 min = 6.30 CT

  – Note: round off cycle time 2 places after the decimal point.

Production Estimation

- Step #7: ***Trips Per Hour***
  - To determine trips per hour (TPH), divide the working minutes per hour by the cycle time.

    $$\frac{\text{Working Min./Hr}}{\text{Cycle Time}} = \text{Trips/Hr (TPH)}$$

- Example:
  - How many trips per hour can a dump truck make during a 60 min. work hour and a cycle time of 6.30 min/trip?

    $$\frac{\text{60 min/hr}}{\text{6.30 CT}} = \text{9.52 TPH}$$

  - Note: Never round off TPH

Production Estimation

- Step #8: ***Hourly Production Rate***
  - To determine the hourly production rate you must know the size of the load (in LCY), the number of trips per hour, and the efficiency of the operator and equipment (Table #7-2 this is the same table used in scraper production).

  TPH x ALS x Efficiency Factor = LCYPH

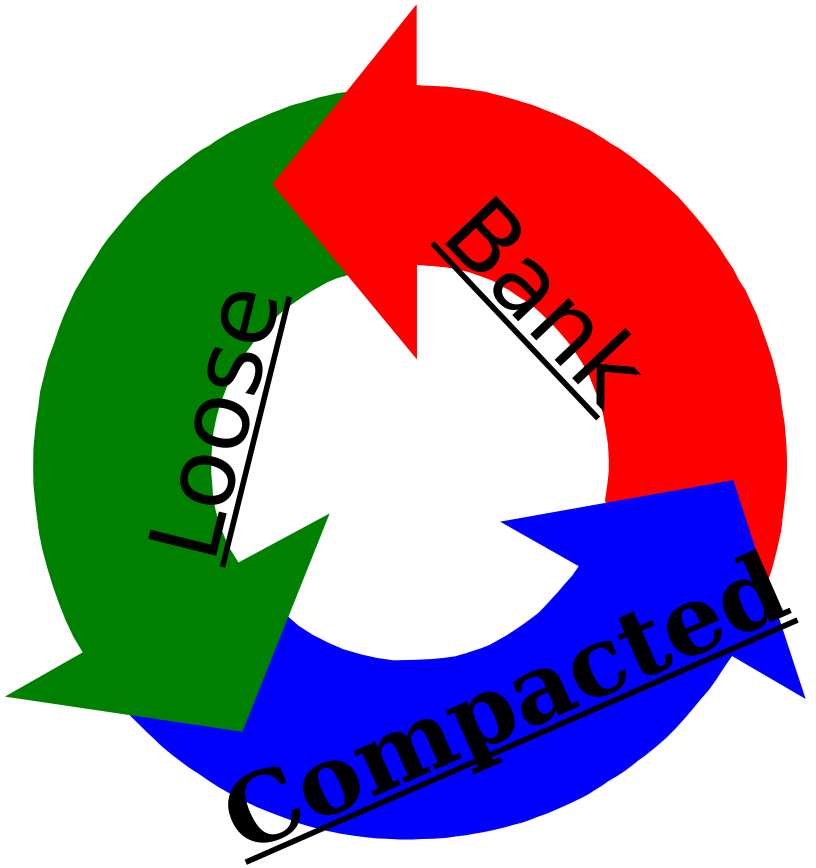
- Example:
  - What is the hourly production rate of a dump truck with an average operator, working a day shift, making 9.52 TPH, with a load of 7.5 LCY?

  9.52 TPH x 7.5 ALS x .60 Eff. Fact. = 42.84 or

  42 LCYPH

Production Estimation

- Step #9: ***Soil Conversion (If Needed)***
  – Convert you type of soil from one state to the other depending on what the job requires.



Production Estimation

- Step #10: ***Ratio Of Trucks To Scoop Loader.***
  - Determine the number of trucks to keep 1 scoop loader moving with no down time.
  - Step #1: ***Loads/hr***

    Loader Production (LCYPH) (step# 1to3 of loader prod.)

    Trucks ALS (LCY/load) = Loads/Hr. Do not round off
  - Step #2: ***Loading Time Per Truck***

    Min worked/hr

    Loads/hr = Loading Time/Truck (min)
  - Step #3: ***Formulate***

    Truck CT (from step 6)

    + 1 = Trucks Req.

Production Estimation

- Example:
  - The TRAM is putting out 150 LCYPH and you are using a 7 ton w/ 2.5 LCY/load. You are working 50 min/hr.

Production Estimation

- Step #11: ***Total Hours Required to Complete Mission***
  - To determine the total time required to complete the mission, you must know the total volume to be moved, the hourly production rate, and the number of trucks you will use on the job.

    $$\frac{1{,}900 \text{ CCY required}}{10 \text{ CCYPH} \times 3 \text{ Dump Trucks}} = 63.33 \text{ Hrs.}$$
  - Note: Never round off time.

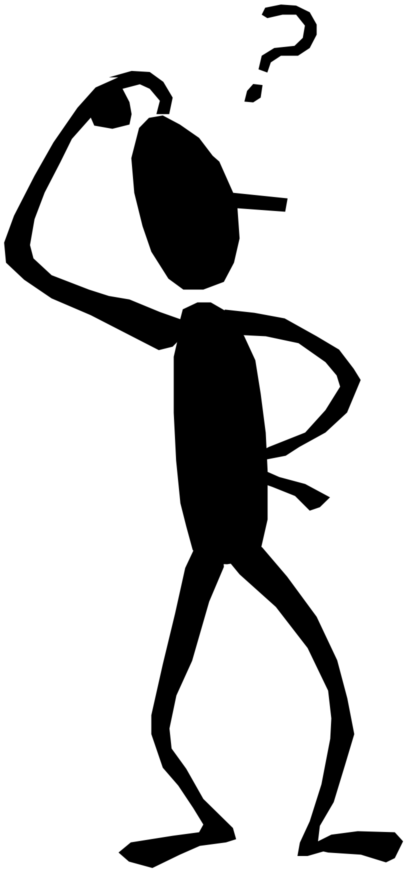
Production Estimation

- Step #12: ***Total Production Days***
  - To get the total days, divide total time required by the hours worked per day.
  - Example:

  $$\frac{63.33 \text{ Hrs. Required}}{8 \text{ Hrs./Day}} = 7.92 \text{ or } 8 \text{ Total Days}$$

Production Estimation

- What have you learned?



- **SOLUTION:**
-
- 2,000 DRY CLAY
- x   1.08 MOISTURE
- 2,160 ASW
-
- 20,000 MAX LOAD SIZE
- ÷ 2,160 ASW
- 9.26 CY OF THE LOAD

- 9.26 CY OF THE LOAD
- ÷ 2.5 BUCKET SIZE
- 3.70
- OR 3 BUCKETS LOADED
- x 2.5 ALS
- 7.5 ALS
-
- 2,160 ASW
- x 7.5 ALS
- 16,200 LW
-

- $\dfrac{6{,}600 \text{ HD}}{35 \text{ X } 88}$ = 2.14 HAUL TIME (HT)
- $\dfrac{6{,}600 \text{ RD}}{50 \text{ X } 88}$ = 1.50 RETURN TIME (RT)
-
- _2.14_ + _1.50_ + _2.00_ = _5.64_
- HAUL TIME RETURN TIME FIXED TIME CYCLE TIME
-
- 60 MIN/HR
- ÷ 5.64 CT
- 10.64 TPH

- 10.64 TPH
- 7.5 ALS
- x .6 EF
- 47.88
- OR 47 LCYPH
- 47 LCYPH
- x .63 CONV FACTOR
- 29.31
- OR 29 CCYPH
- 5.64 TCT
- ÷ .50 LCT
- 11.28
- \+ 1.00
- 12.28
- OR 12 TRUCKS REQUIRED

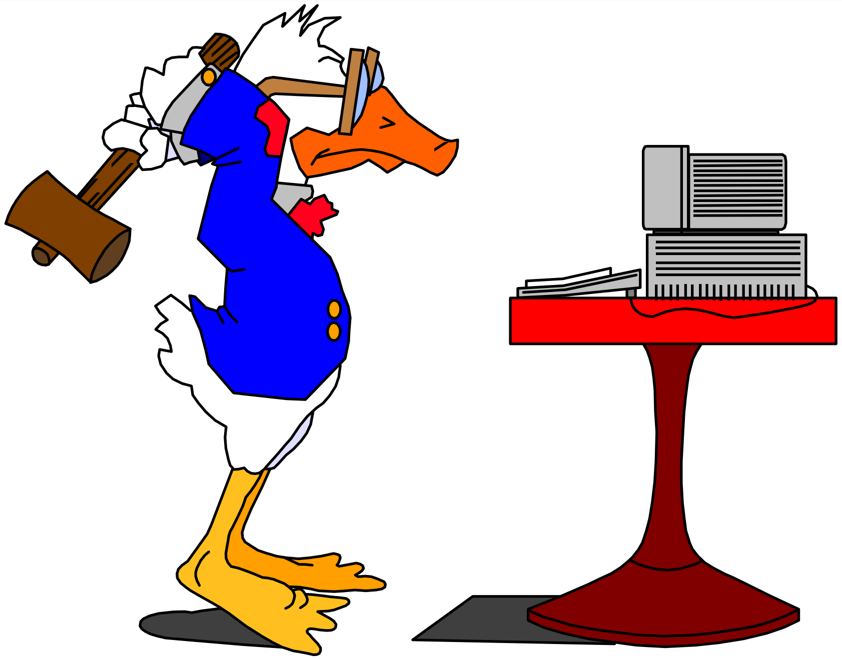
170,000 FILL REQUIRED
÷ (29 x 12)
488.51 THR

488.51
÷ 10
48.85
OR 49 DAYS REQUIRED

QUESTIONS

BREAK 10 MIN

LOGISTICAL ESTIMATION SUPPORT

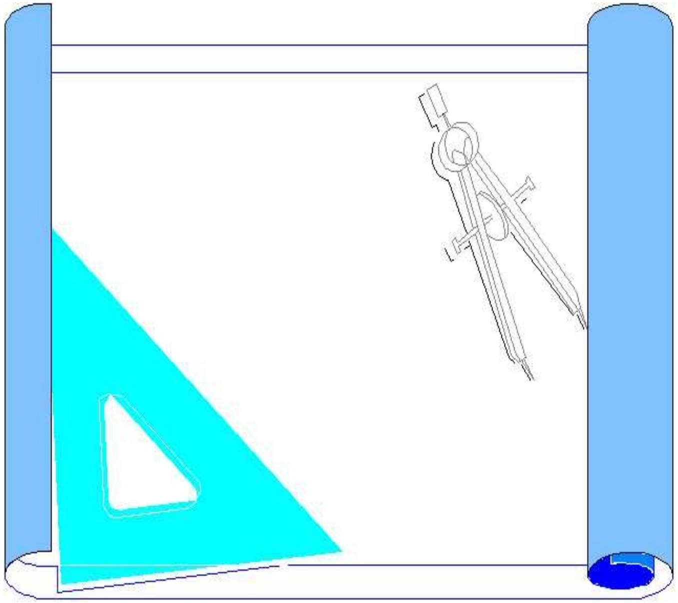


RESPONSIBIITIES

- ENGINEER OFFICER
- ENGINEER CHIEF
- ENGINEER NCO

ENGINEER OFFICER

- CONDUCT SITE RECONNAISSANCE
- ORDER SURVEY
- ORDER SOIL ANALYSIS
- ORDER ENVIRONMENTAL IMPACT STUDY



ENGINEER OFFICER

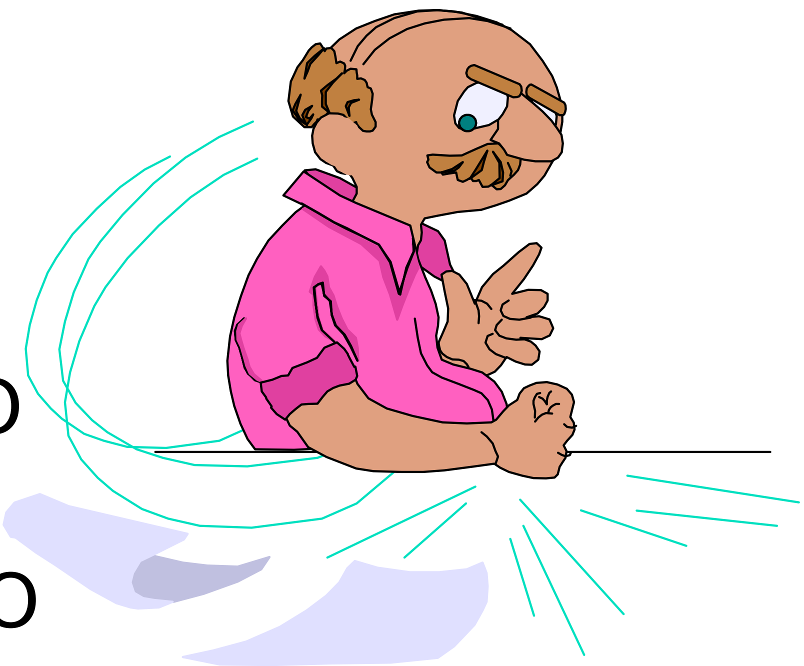
- ORDER GRADE STAKES TO BE PLACED AND ENVIRONMENTAL AREAS MARKED
- SUPPLY BLUE PRINT AND ENVIRONMENTAL STUDY TO CHIEF

ENGINEER OFFICER

- ORDER CHIEF TO MAKE WRITTEN ESTIMATIONS FOR EACH AREA OF CONCERN
- COLLECT DATA FROM ALL CHIEFS AND FORMULATE TOTAL ESTIMATION

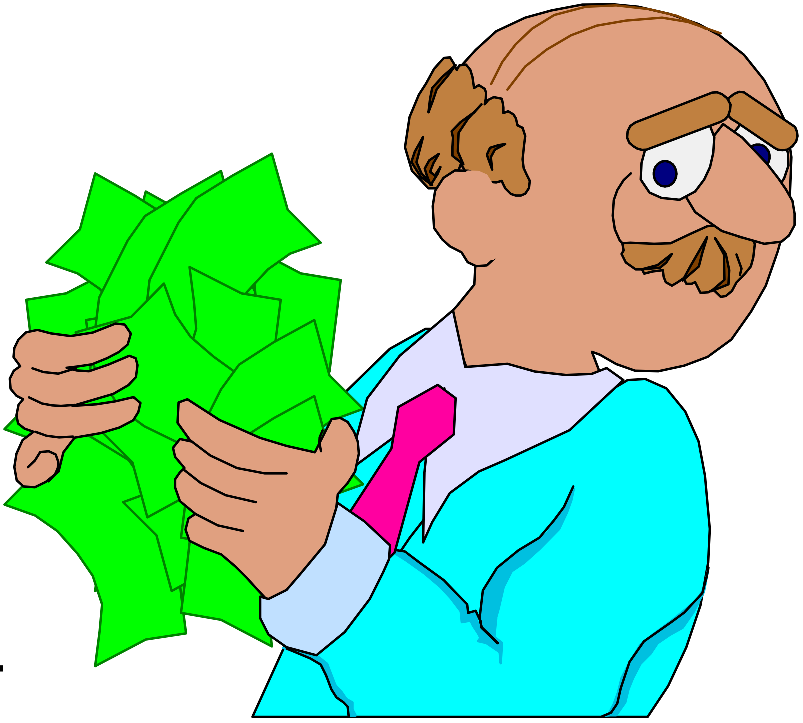
ENGINEER OFFICER

- IDENTIFY CONSTRUCTION REQUIREMENTS / LIMITATIONS / RESTRICTIONS
- USE CRITICAL PATH METHOD TO PLAN PROJECT
- ISSUE ORDERS TO CONDUCT MISSION



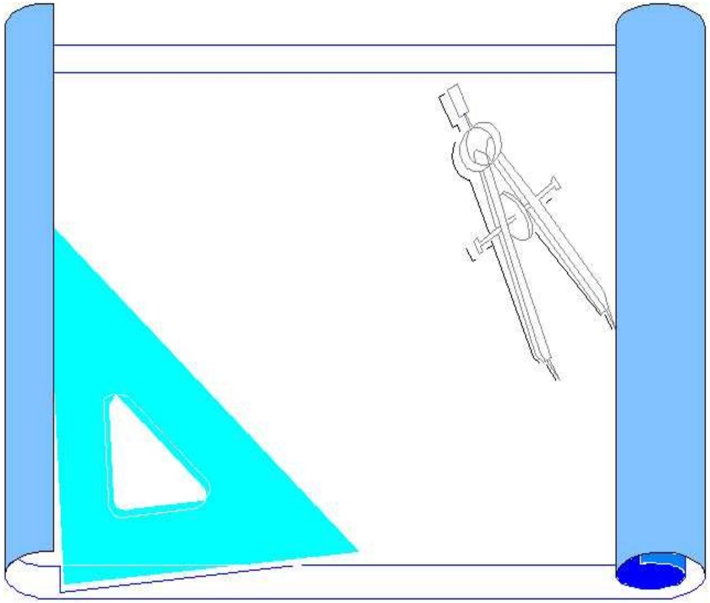
ENGINEER CHIEF

- CONDUCT SITE RECON.
- READ SURVEY (BLUE PRINT)
- GET SOIL ANALYSIS INFO
- VIEW ENVIRONMENTAL IMPACT STUDY



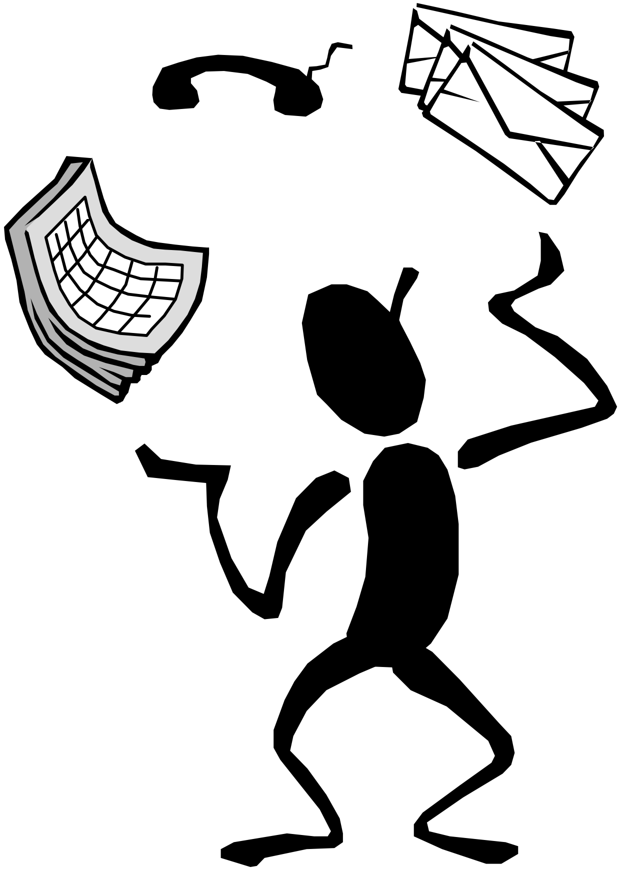
ENGINEER CHIEF

- MAKE ESTIMATIONS OFF OF MEASUREMENTS GIVEN IN BLUE PRINT



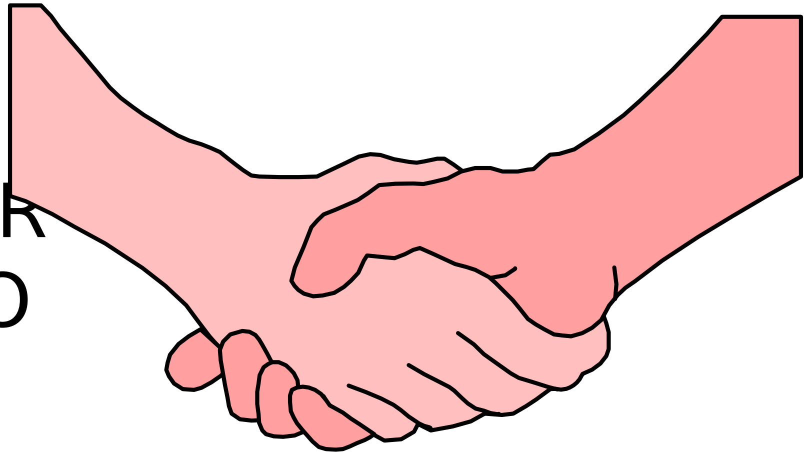
ENGINEER CHIEF

- MAKE MATHEMATICAL ESTIMATIONS FOR EQUIPMENT, PERSONNEL, TIME, AND MATERIALS
- PLAN ORDER OF WORK USING CRITICAL PATH METHOD



ENGINEER CHIEF

- RETURN WRITTEN ESTIMATION TO ENGINEER OFFICER
- ISSUE THE ORDER TO THE NCO'S TO EMPLOY EQUIPMENT



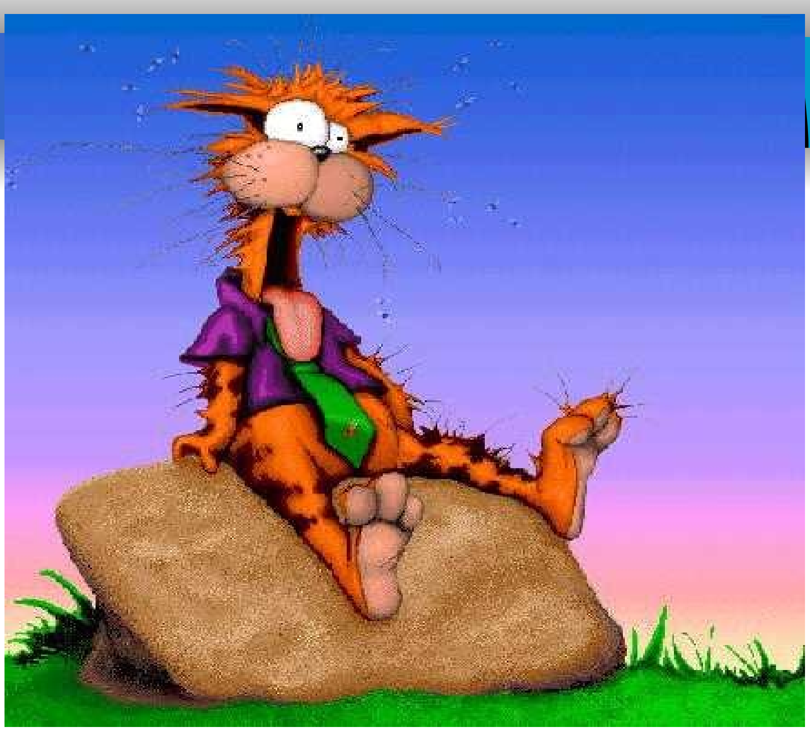
ENGINEER NCO

- REQUEST THE SUPPORT OF FUEL, OILS, WATER AND CHOW
- COORDINATE EQUIPMENT TO AND AT THE JOB SITE
- SUPERVISE CREWS AND TEAMS

QUESTIONS?

- Any Questions??
- Take a break

ESTIMATING LOGISTICS



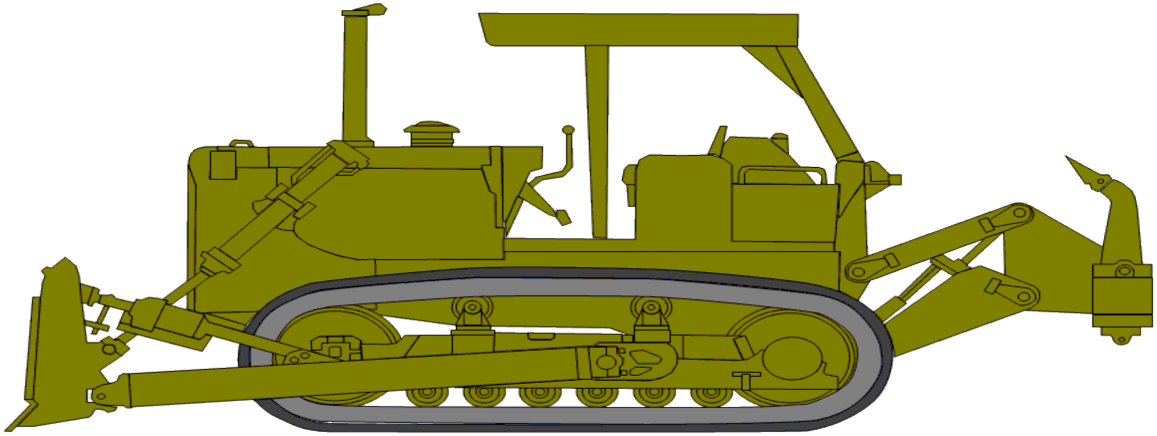
LOGISTICAL ESTIMATIONS

- TO MAKE THE WRITTEN ESTIMATIONS REQUIRED, THE FOLLOWING FORMULAS MUST BE USED

FUEL CONSUMPTION

- # __________ X _________ X __________ X ___________ =
- # OF EQUIP X GALS/HR X HRS/DAY X # OF DAYS =

TOTAL GALS OF FUEL



USE TABLE #1 FOR GALS PER HOUR FOR EACH TYPE OF ENGINEER EQUIPMENT

ADD TOTALS FOR EACH TYPE OF EQUIPMENT TOGETHER TO GET TOTAL FUEL REQUIREMENT

FUEL CONSUMPTION

TABLE #1 FUEL CONSUMPTION

EQUIPMENT	TYPE OF FUEL	GALS/HOUR
LOADER 624KR	DIESEL/JP8	6.00
MAC 50 (ATC)	DIESEL/JP8	6.00
GRADER (120M)	DIESEL/JP8	4.00
COMPACTOR(563D)	DIESEL/JP8	4.00
SCRAPER (621B)	DIESEL/JP8	10.00
DOZER (1150E)	DIESEL/JP8	6.00
DOZER (1155E)	DIESEL/JP8	6.00
DOZER (MCT)	DIESEL/JP8	8.00
BACKHOE (420E)	DIESEL/JP8	4.00

DEMONSTRATION

SEE EXAMPLE IN HANDOUT

TOTAL FUEL CONSUMPTION FOR 3 SCRAPERS (621B) WORKING 12 HR/DAY FOR 10 DAYS AND 2 TRAMS (624KR) WORKING 12 HR/DAY FOR 4 DAYS, ALSO 2 GRADERS (120M) WORKING 12 HR/DAY FOR 13 DAYS

SOLUTION

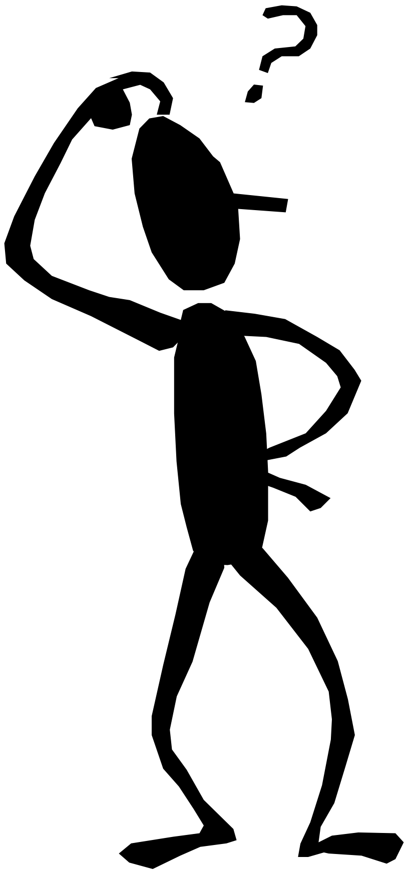
EQUIP X GALS/HR X HRS/DAY X #DAYS = TOTAL FUEL REQUIRED

- 621B X X X =
- 644E X X X =
- 130G X X X =

TOTAL GALS

WHAT HAVE YOU LEARNED

- WORK THE "WHAT HAVE YOU LEARNED" PROBLEM IN YOUR STUDENT HANDOUT



SOLUTION

- EQUIP X GALS/HR X HRS/DAY X #DAYS = TOTAL FUEL REQUIRED

X X X =

X X X =

X X X =

TOTAL =

GALS

P. O. L.

ONCE TOTAL GALLONS OF FUEL HAVE BEEN COMPUTED ALL OTHER P.O.L. REQUIREMENTS CAN BE ESTIMATED

P.O.L. STEP 1

- 10 WT THROUGH 50 WT

.02 X TOTAL GALS FUEL = TOTAL OE

P.O.L STEP 2

- 80 WT THROUGH 90 WT

  .005   X   TOTAL GALS FUEL   =   TOTAL

P.O.L STEP 3

- GREASE OR GAA

  – STEP 1 DETERMINE ESTIMATED METER HOURS

  # OF EQUIP X HR/DAY X #DAYS =
  EST METER HOURS

P.O.L STEP 3 CONT.

<u>EST METER HOURS</u>

8 X .25 = GAA LBS

The 8 is for 8 hours on the meter the .25 is for 1/4 lbs. of grease for every 8 meter hours.

EXAMPLE

2 GRADERS (120M) WITH AN ESTIMATED TOTAL FUEL CONSUMPTION OF 1,248 GALS, AND AN ESTIMATED 13 TOTAL DAYS OPERATED.

SOLUTION

10 WT THROUGH 50 WT

X EST FUEL NEEDED = OR

GALS OE

80 WT THROUGH 90 WT

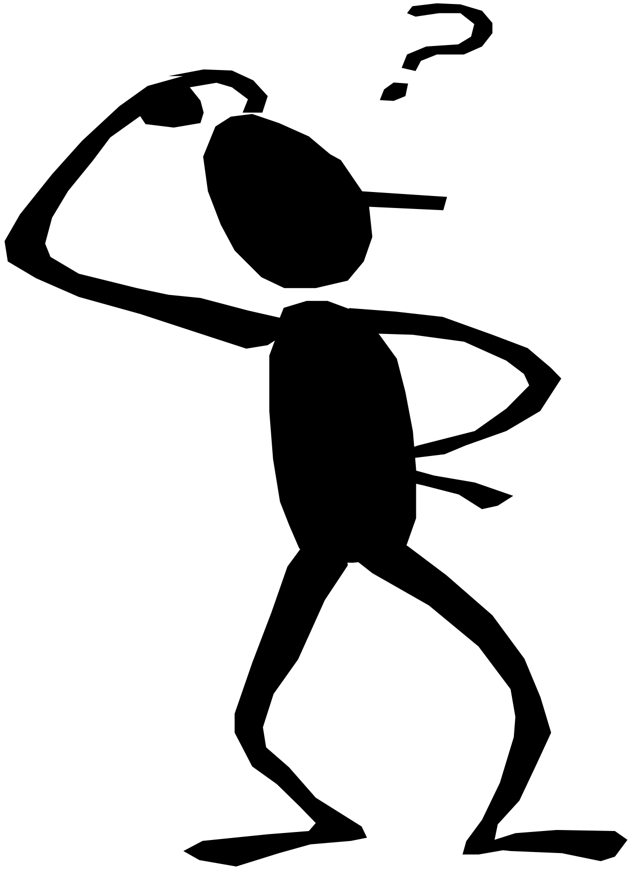
X EST FUEL NEEDED = OR

GALS GO

GREASE OR GAA

WHAT HAVE YOU LEARNED

WORK THE “WHAT HAVE YOU LEARNED” PROBLEM IN YOUR STUDENT HANDOUT



SOLUTION

3 TRAMS (624KR)

.02 X 3,500 EST FUEL NEEDED = 70 GALS OE

.005 X 3,500 EST FUEL NEEDED = 17.5 OR 18 GALS OE

3 Trams X 7 HRS/DAY X 8 DAYS = 168 EST MTR HRS

EST METER HRS

$$\frac{168}{8} \times .25 = 5.25 \text{ OR } 6 \text{ LBS GAA}$$

SOLUTION CONT.

2 420E

X EST FUEL NEEDED = GALS OF OE

X EST FUEL NEEDED = GALS OF GO

420E X HR/DAY X DAYS = EST MTR HRS

EST METER HRS

X = OR LBS GAA

SOLUTION CONT.

	OE GAL	GO GAL	GAA LBS
TRAM	70	18	6
420D	24	6	4
TOTALS	94	24	10

WATER CONSUMPTION

- POTABLE
- NON-POTABLE

WATER CONSUMPTION

USE TABLE #2 TO COMPUTE WATER REQUIREMENTS FOR:

- SOIL PREPARATION AND DUST CONTROL (NON-POTABLE)
- EQUIPMENT (NON-POTABLE)
- DRINKING (POTABLE)
- PERSONAL HYGEINE (POTABLE)
- SHOWERS (POTABLE)
- LAUNDRY (POTABLE)

SOIL PREPARATION AND DUST CONTROL

NON-POTABLE

TOTAL SQ. YD. X 1 GAL/SQ. YD. X 1.10 WASTE = GALS REQ

EQUIPMENT FORMULA

NON-POTABLE

QTY OF EQUIP X 1 GAL/DAY X EST DAYS X 1.10 WASTE =

GALS REQ

SHOWERS FORMULA

- POTABLE

- # PERSONNEL X TABLE 2 X 1.10 WASTE = GALS REQ

LAUNDRY FORMULA

- POTABLE
- # PERSONNEL X TABLE 2 X DAYS X 1.10 WASTE

  = GALS REQ

HYGIENE FORMULA

- POTABLE
- # PERSONNEL X TABLE 2 X DAYS X 1.10 WASTE

  = GALS REQ

DRINKING WATER FORMULA

POTABLE

PERSONNEL X TABLE 2 X DAYS X 1.10 WASTE = GALS REQ

EXAMPLE

ESTIMATE THE WATER CONSUMPTION FOR 250 PERSONNEL WORKING FOR 28 DAYS IN A HOT CLIMATE. COMPUTE THE REQUIREMENT FOR 50 VEHICLES. YOU WILL BE WORKING ON A ROAD THAT IS 4,000’ LONG AND 28’ WIDE FROM DITCH TO DITCH.

SOLUTION
SOIL PREPARATION

NON POTABLE

$$\frac{4{,}000' \text{ L X } 28' \text{ W}}{9} = 12{,}444.44 \text{ OR } 12{,}445 \text{ SQ YD}$$

12,445 SQ YD X 1 GAL X 1.10 = 13,689.5 OR 13,690 GAL

SOLUTION CONT. EQUIPMENT

NON POTABLE

VEHICLES X GAL/DAY X DAYS X WASTE = GALS

SOLUTION LAUNDRY AND SHOWERS

POTABLE

Laundry:

250 PERSONEL X 2.1 GAL/DAY X 4 DAYS X 1.10 WASTE = 2,310 GALS

Showers:

250 PERSONEL X 1.0 GAL/DAY X 4 DAYS X 1.10 WASTE = 1,100 GALS

SOLUTION CONT. HYGIENE WATER

POTABLE

250 PERSONS X 1.7 GAL/DAY X 28 DAYS X 1.10 WASTE = 13,090 GALS

SOLUTION CONT.
DRINKING WATER

POTABLE

250 PERSONS X 3 GALS/DAY X 28 DAYS X 1.10 WASTE =

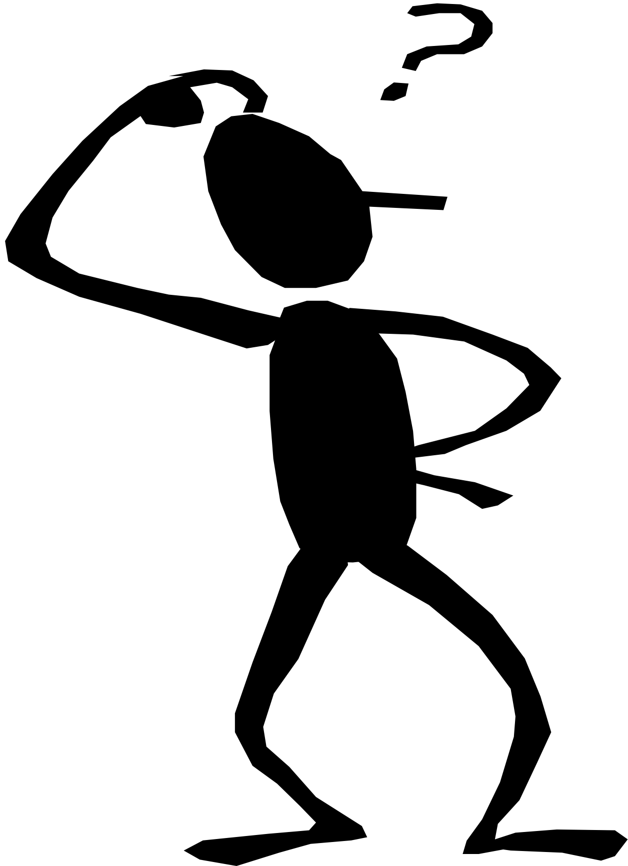
23,100 GALS

Table for Water Consumption

	POTABLE	NON-POTABLE
SOIL PREPARATION		**13,690**
EQUIPMENT		**1,540**
LAUNDRY	**2,310**	
SHOWERS	**1,100**	
HYGEINE	**13,090**	
DRINKING WATER	**23,100**	
TOTALS	**39,600**	**15,230**

WHAT HAVE YOU LEARNED

WORK THE “WHAT HAVE YOU LEARNED” PROBLEM IN YOUR STUDENT HANDOUT



SOLUTION

SOIL PREP

$$\frac{6{,}099' \text{ L} \times 24' \text{ W}}{9} = 16{,}264 \text{ SQ YD}$$

16,264 SQ YD X 1 GAL X 1.10 WASTE = 17,891 GALS

SOLUTION CONT.

EQUIPMENT

25 VEHICLES X 1 GAL/DAY X 60 DAYS X 1.10 = 1,650 GALS

SOLUTION CONT.

LAUNDRY (ONCE A WEEK)

75 MEN X 2.1 GAL/MAN X 8 DAYS X 1.10 =

1,386 GALS

SOLUTION CONT.

SHOWERS (ONCE PER DAY)

75 MEN X 1.0 GAL/MAN X 60 DAYS X 1.10 =

4,950 GALS

SOLUTION CONT.

PERSONAL HYGIENE

75 MEN X 1.7 GAL/MAN X 60 DAYS X 1.10 =

8,415 GALS

SOLUTION CONT.

DRINKING

75 MEN X 3 GAL/MAN X 60 DAYS X 1.10 =

14,850 GALS

SOLUTION CONT.

	POTABLE	NON-POTABLE
SOIL PREPARATION		**17,891**
EQUIPMENT		**1,650**
LAUNDRY	**1,386**	
SHOWERS	**4,950**	
HYGEINE	**8,415**	
DRINKING WATER	**14,850**	
TOTALS	**29,601**	**19,541**

MEALS READY TO EAT

- Most common form of sustenance
- Easy to carry/transport

MRE FORMULA

#PERSONNEL X 3 MEALS/DAY X #OF DAYS =

TOTAL # OF MEALS

$$\frac{\text{TOTAL \# OF MEALS}}{12} = \text{TOTAL \# OF CASES}$$

EXAMPLE

THE UNITS SIZE IS 175 PERSONNEL, WORKING 60 DAYS, DETERMINE THE QUANTITY OF MEAL READY-TO-EAT, BY THE CASES.

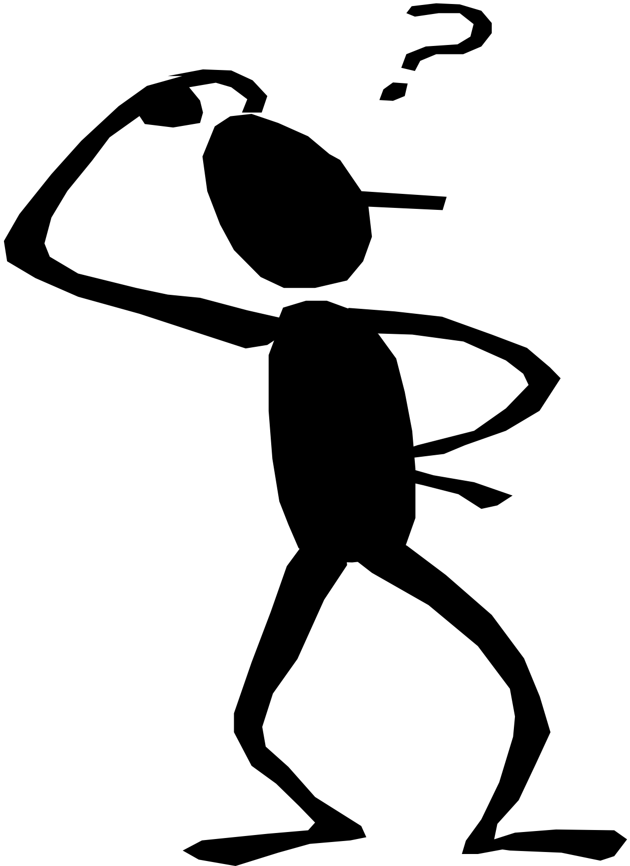
SOLUTION

- 175 PERSONNEL X 3 MEALS/DAY X 60 DAYS = 31,500 TOTAL MEALS

- 31,500 TOTAL MEALS / 12/CASE = 2,625 CASES

WHAT HAVE YOU LEARNED

WORK THE “WHAT HAVE YOU LEARNED” PROBLEM IN YOUR STUDENT HANDOUT



SOLUTION

- 30 PERSONNEL X 3 MEALS/DAY X 20 DAYS = 1800 TOTAL MEALS
- 1,800 TOTAL MEALS / 12/CASE = 150 CASES

PRACTICAL APPLICATIONS

- Worksheet 1
- Worksheet 2
- Worksheet 3

QUESTIONS?

SUMMARY